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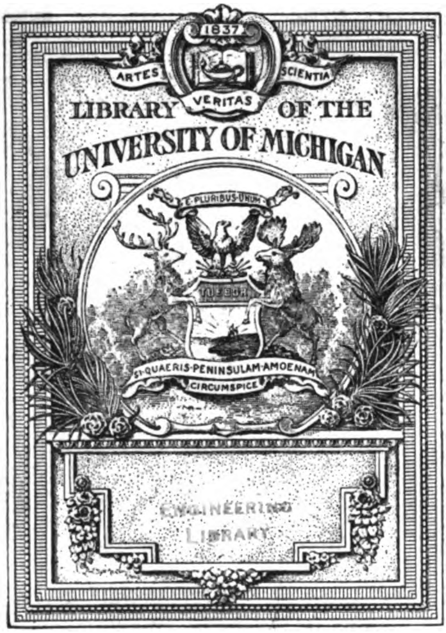

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ANNUAL REPORTS

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FOR THE

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CHIEF OF ENGINEERS.

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UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., July 1, 1897.

GENERAL: I have the honor to transmit herewith annual reports upon works of river improvement in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

U 1.

IMPROVEMENT OF RED RIVER, LOUISIANA AND ARKANSAS.

Operations during the fiscal year ending June 30, 1897, for general improvement of Red River between Fulton, Ark., and the head of Atchafalaya River, Louisiana, a distance of 508.6 miles, were continued by the U. S. snag boat *C. W. Howell*, and during the low-water season the U. S. snag boats *O. G. Wagner* and *John R. Meigs* were employed in Lower Red River and a shore party in the old raft region above Shreveport.

Details of the work done are as follows:

The U. S. snag boat *C. W. Howell*, M. B. Lydon, master, left the mouth of Sulphur River, Arkansas, 80¾ miles above Shreveport, La., July 7, 1896, to work downstream. The stage at the locality was the lowest of record, due to a great extent to the scouring and lowering of the bottom of the river through the old raft region. In the reach above Horseshoe Bend only 14 inches depth of channel was found, and three and one-half hours was spent in pulling over the bar. On arriving at Missionary, La., July 8, it became necessary to tie up, cool boilers, and repair the mud drum; but the crew was sent down to Head of Raft, 3 miles below, to remove shore snags, stumps, and logs. On the morning of the 9th the boat again started downstream, but in rounding-to, after backing over a sand bar extending from Missionary to Lake Place, struck a hidden stump and broke the balance rudder and stock, repairs of which detained it until 9 a. m. the next day. July 10–14 work was carried down through the old raft region to Shreveport.

After receiving supplies, the *Howell* left Shreveport the morning of July 16 for work in the lower river, which was carried down to Snaggy Point Bar, 37 miles below Alexandria. In addition to general work on the way down, the boat stopped at Browns Reach, Golddust, and wreck of the steamer *Falls City* to remove special obstructions reported by steamboat men. No very shoal water was found until July 19, when the boat reached Tessier Bar, 139 miles below Shreveport. At that point the river divided in two chutes, with not to exceed 2 feet depth in either, and the crew was employed until the morning of July 25 closing one of the chutes with a pile-and-brush dike. Work then continued downstream, but the mud drum was leaking so badly that on July 27 it was decided to run to Alexandria for repairs. After working day and night, the repairs were completed July 29. July 30–August 3 was spent at Poland Cut-off blasting hard-clay points, cutting leaning timber, and removing obstructions in the channel, and August 4–7 at Snaggy Point Bar, where a pile dike 450 feet long was built from the right bank to near the head of the wreck of steamer *E. B. Wheelock*, to narrow the channel and cause the bottom to scour.

August 8 the *Howell* turned back to work upstream, removing snags, stumps, leaning trees, etc., on the way. Soundings were taken on Stonewall and Alexandria bars August 10, but as channel depths of 5 feet were found, with Alexandria gauge reading 0.5 foot below zero, work at those places was not required. The old dike at Swilly Bar, 5½ miles above Alexandria, built November, 1894, was found intact and 4½ feet depth of channel. St. Andre Bar was pulled over August 13, but there was only 30 inches depth, with water running in two channels. One chute was closed by a pile-and-brush dike 300 feet long, completed August 15. On reaching Prudhomme Bar, August 20, only 28 inches depth was found, and a dike 195 feet long was completed at that place and the channel cleared of snags and stumps August 22. August 25–28 the boat was employed in building 550 feet of dikes and in removing snags and stumps at Shire Bar, where there was only 1 foot depth over a hard gravel bottom. August 31 and September 1 a dike 325 feet long was built at Hecla Bar, where the channel was changing and shifting rapidly on account of a bed of quicksand. Tessier Bar was reached September 3, and the boat was employed at that locality until September 10, the river being shallow for a long distance and again divided in two channels. A dike 700 feet long was built at the upper end to close the left channel, and three spurs, aggregating about 500 feet in length, were built to increase the scour. On completion of this work, the morning of September 10, the *Howell* backed over the bar and continued operations upstream, removing obstructions in the channel, and on account of the extreme low stage finding bars never heard of before. October 1–3 the boat was employed at the wreck of the steamer *C. E. Satterlee* (sunk 1893), in Rock River Bend, where the right chute was cleared of obstructions and a dike 175 feet long built to close the left chute and prevent the channel from cutting into the bend. October 4–8 were spent in removing obstructions in Galconda Bend, and on the 9th the *Howell* pulled over the bar at that place and continued work above. The wreck of the steamer *Gladiola* (sunk July 14, 1875), at Closo Point, was reached October 10. The head of the wreck projected into the channel and was removed. Otherwise there was a good channel at that place. Campti was reached that night, and the boat laid at that place until noon October 13 undergoing repairs of capstan and shears. October 14–20 were spent at Rosa Bar, where it was found necessary to fix the caving bank with a protection of pile and mattress work, weighted with boxes of earth. During the remainder of October the *Howell* was employed at Marcy Bar, just above and a continuation of Rosa Bar, where about 690 feet of brush dams were built to contract and fix the channel. In November operations were carried up to Loggy Bayou, a distance of 53 miles. In this stretch there were no shoal places, and the least depth found was 4 feet, sufficient to permit the boat to work to advantage, though the number of obstructions found was small in comparison with former years. At Star Point a large wrack heap, which almost blockaded the river and had caused a gravel bar formation, was removed November 27. The larger logs and stumps were pulled out or blown up with explosives, and after removing these obstructions the *Howell* pulled over and washed the bar with her wheel, causing it to scour and dissipate in deep water below. December 1–26 work was continued to Shreveport, the boat removing all obstructions in sight or that could be located. December 1–5 the water rose about 6 feet, ranging from 2 feet below to 4 feet above zero of the Shreveport gauge. On the 3d heavy drift commenced running and continued for three days, until the crest of the rise had passed, an occurrence unusual at so low a stage, and probably due to the prolonged drought and the large amount of work done by the shore party above Shreveport. On the 23d the *Howell* reached Mack Bayou Bar, 3 miles below Shreveport, the first place where it was necessary to lay a line after passing Marcy Bar, 114 miles below, October 31. A brush wing dam about 125 feet long was built to close the right chute and force the water to the other side, which afforded 4 feet depth at once, with Shreveport gauge reading 1.3 feet below zero.

After reaching Shreveport, December 26, the crew was laid off temporarily, and needed repairs of boiler and mud drum were made. These repairs were completed January 7, and after taking on supplies and coal operations in the river above Shreveport were resumed. A jam of drift at the Shreveport bridge was removed January 8. January 9–11 the boat worked up to mouth of Sulphur River, Arkansas, and was employed in that tributary until January 31, when it returned to Shreveport for supplies.

February 2–March 5 the *Howell* worked from Shreveport, La., to Fulton, Ark., 188 miles. The river was at a low stage, and effective work was done for clearing a channel for passage of the small class of steamers which navigate the upper river. February 17 the snag boat struck a hidden stump, just above the mouth of Sulphur River, which knocked a small hole in the iron bottom near the bow, and February

24, while passing the draw of the railroad bridge at Garland, Ark., it hit an obstruction in the channel and broke another hole through the bottom. Both leaks were battened, and work continued without much loss of time. The worn condition of the bottom, the very low stage, which brought numerous cypress stumps and other dangerous obstructions near the surface without sufficient current to indicate them; the fact that the crew had to cut wood for fuel, none being for sale along the banks, and the need of keeping a constant head of steam to siphon the water leaking through the holes in the bottom, delayed progress considerably. The sweep chain was kept out constantly to clear the channel and lessen the danger to the bottom of the snag boat. Fulton was reached on a stage of 2.5 feet on the gauge at that place (2.4 feet above the lowest of record), the lowest upon which the *Howell* ever had worked so far upstream. March 6 the boat passed above the Missouri Pacific Railway Bridge at Fulton, and was employed that day near the locality.

On March 8 preparations for repairing the iron bottom of the vessel, where damaged on the way upstream, were commenced. Lumber of dimensions required for building a temporary sectional dock could not be had at Fulton until logs were brought out of Little River and sawed, and oakum, canvas, spikes, iron plates, etc., had to be shipped partly from Memphis, Tenn., and partly from New Orleans, La. By March 12 the dock was completed, sunk under the *Howell*, and pumped out, and on the 17th the work of drilling, fitting, and riveting four iron sheets on the bottom at bow was finished. The dock then was withdrawn and rebuilt to fit the side of the vessel, where an iron patch was fitted March 20.

The *Howell* was ready to resume work March 22, but during the period of repairs a rise had set in, the gauge at Fulton that date reading 28.5 feet, rising. As the bulkhead for protecting the upper end of Red Bayou Levee had been reported damaged from firing the grass in that locality, and the end sloughing, 1,000 sacks were procured from Texarkana, and the boat left for the levee March 23. Upon reaching West Garland that afternoon, signal was given for opening the draw of the St. Louis Southwestern Railway Bridge in the bend below, but after getting in sight of the bridge and finding it closed the engines were stopped, and the boat was driven in shore by the wind. The bridge tender finally succeeded in opening and wedging the draw, and after about an hour's delay in getting away from shore and waiting to see if the draw could be held open, the master of the *Howell* attempted passage of the bridge, finding that the boat handled well, and with all confidence of going through safely. The boat was held up to the wind as close to the bridge as possible, but in squaring to pass the draw the force of the gale struck the vessel broadside, and, in connection with the strong current, was too much for her, causing her to strike the bridge pier a glancing blow. Mate Charles Williams, colored, was on the forecastle, and, foreseeing the accident, seized a stick of wood and placed it between the boat and pier to lessen the effect of the impact upon the iron vessel. The jar was so severe, however, that he was thrown overboard, and though a yawl was lowered immediately and every effort made to rescue him, he drowned before aid could reach him. Beyond a dent in the bow and the demolition of the engine-room bulkhead, the *Howell* was not damaged materially, and after making temporary repairs continued downstream the following day and reached Red Bayou Levee at 8 a. m. March 25. By that time the water was rising fast, and work of repairing the bulkhead and strengthening the end of the levee was pushed vigorously. The repairs were completed, the slopes strengthened and protected by mattresses of wired cane weighted with sacks of earth, and the crown raised above high-water mark March 29, and the boat returned to Shreveport March 30.

March 31–April 6 the *Howell* remained at Shreveport undergoing repairs of after bulkheads, wheel, fenders, etc. On the 7th it ran down to Tones Bayou, and the crew was employed at that place until the afternoon of the 10th repairing and strengthening the bulkheads at lower end of the levee across Staten Point, abutting upon Tones Bayou. The brush and sacks of earth placed at that point the latter part of March, 1896, had rotted away, and were replaced as before, except at end of the spur, which was raised, sloped, and sodded. After returning to Shreveport, the crew was reduced and necessary minor repairs were continued. The shears were taken down and rebuilt, a large yawl was rebuilt, the after bulkhead was painted, new stanchions were made and put up, the bow deck was patched, pipes for forge and pilot house were renewed, the wheel was stripped, a small sectional dock sunk under the after end of the vessel, and three sheets of boiler iron fitted and riveted in place to repair holes in the iron bottom, after which the wheel was repaired.

This work was completed Saturday, May 15. Late that evening notification was received that the upper river was jammed with drift at several places. May 16 the master of the *Howell* was ordered by telegraph to make a patrol for the purpose of destroying jams, etc., to examine levees and bulkheads, and to do such other work as might be needed. After obtaining a crew and taking on coal and supplies, the *Howell* left Shreveport at 6.40 a. m. May 17 and reached Fulton at 6 a. m. May 20. Above Sulphur River a strong current and heavy drift were encountered, and a small jam was broken up at the Garland Bridge. May 20–22 work continued between Fulton and the Kansas City, Pittsburg and Gulf Railroad Bridge to start the drift downstream and keep it in motion. At the bridge, with the aid of a gang of laborers hired by the railroad company, a narrow channel was cleared through the draw, but the water fell so rapidly that a large amount of drift stranded above. May 23–27 the boat returned to Shreveport. The temporary pilot, whose services had been obtained at Shreveport, was called by telegraph to New Orleans, on account of serious illness in his family, and, as it was found impracticable to secure another pilot without delay, the master of the *Howell* made the return trip at the wheel. Levees, dikes, and bulkheads were inspected on the way down, and found intact and in good condition, except at Cash Point, 14 miles above Shreveport, where the Bossier bank had caved into the crown of the levee.

From May 28 until June 30, 1897, the *Howell* remained at Shreveport undergoing minor repairs.

The following is a summary of the work done in Red River by the snag boat *Howell* during the year, viz:

Snags pulled	1,735
Stumps pulled	437
Shore snags cut	1,492
Logs removed from channel	3,685
Trees removed from channel	11
Leaning trees cut	1,722
Hard clay points removed with explosives	4
Wrack heaps removed	1
Jams removed	3
Side jams removed	20
Old piles destroyed at Fulton (Ark.) Bridge	12
Levee bulkheads repaired and strengthened	4
Linear feet pile and brush dams built	4,506

Wrecks removed, viz: Parts of steamers *Gladiola*, *Drover*, and *D. C. Horton*, and sunken barge.

The U. S. snag-boat *O. G. Wagner*, Watkins Decker, master, was employed between Alexandria and the mouth of Black River, Louisiana, during the exceptionally low stages, August 3–October 31, 1896. Obstructions were removed from nearly all bars, and in bends and reaches, except at Poland Cut-off and Snaggy Point Bar, which had been cleared by the snag boat *Howell*. Heavy work was done at the following localities, viz: Pineville and Alexandria reaches, Williams's sawmill, Rodgers Place, Jones Quarters, Creole Bend, Stonewall, Grimes Bluff, Glover Bar, Midway, Berlin Bend, Sauciers, Aymond Bar, bend below Cottonwood Bayou, Dick Johnson's, Normand, and Co Co Bend; in Co Co Bend 15 stumps, 1 to 3 feet in diameter and 4 to 8 feet long, embedded in the bottom, were removed; at Reno Bar, bend below Wares, Toller, from head of bend above Confederate Raft to foot of bend below Negro Point, from Saline Bayou to Little Prairie Bend, at Lenoir Point, Kalamazoo Landing, and between Murray Place and head of Grand Bend.

This work was done prior to September 17. On the way down nothing could be done from the bend below Co Co to the bend above Confederate Raft, and in the stretches between Negro Point Bend and Saline Bayou, at Little Prairie Bend, and between Kalamazoo and Murray Place, as the snag boat was unable to obtain sufficient fuel. The bends above and below Confederate Raft were freed of snags, the channel in the latter was straightened, and the depth, which had been 20 inches, was increased to 30 inches by the work. The removal of snags at wreck of steamer *Col. A. P. Kouns*, sunk in 1877 at Negro Point, increased the depth on the bar by 10 inches. From Saline Bayou to head of Little Prairie Bend the channel was cleared of numerous caved-in trees, stumps, etc. At Lenoir Point six snags and a stump were removed from middle of the channel, and at Kalamazoo Landing a stump and log in the channel, which detained the steamer *Anna B. Adams*, were removed.

September 17 the *Wagner* ran down to head of Grand Bend and commenced working upstream. Between Grand Bend and the Rapions the channel was almost blocked by caved-in trees, and the Rapions were so badly obstructed by snags and stumps that it required three hours for the *Wagner* to run the 3 miles from head of Rapions to Grand Bend. Subsequently 133 snags and 16 stumps were destroyed in this short stretch, and operations were continued up to Murray Place.

October 3 the snag boat ran down to Black River to receive supplies shipped from New Orleans by Ouachita steamboat, Red River boats having stopped for the time. The boat having been delayed, the *Wagner* worked in that locality until October 7. October 8–10 it was employed at what is known as "The Funnel," on Grand Point, removing leaning timber, etc. October 12–29 it worked over the stretch between Little Prairie Bend and Bordelon Point, about 8 miles, and the last two days of the month it returned to Black River to be ready to commence work in that stream in November.

The stage at Negro Point and Confederate Raft in October was about 2 feet lower than when the *Wagner* worked at those localities the preceding month, but notwithstanding the fall there was greater depth on the bars. The scour during this period uncovered snags in the channel impossible to locate before. Extra labor was hired the latter part of October and employed in clearing the banks along a badly obstructed stretch above and below Confederate Raft in conjunction with snagging operations in the channel. The timber was felled for distances of 10 to 50 feet back from the river, portions of the banks which were caving or showing a tendency to cave having been cleared farthest back. All channel obstructions that could be located or caught with the drag chain were removed, and care was used to deposit snags in out of the way places where they could not get into the channel again.

The following is a summary of the work done by the *Wagner* August 3-October 31, 1896, viz:

Snags pulled	854
Stumps pulled and destroyed	187
Stumps cut	462
Shore snags cut	535
Logs cut	62
Leaning trees felled	4,536
Trees girdled	147

Wrecks removed: Old ferry at Alexandria.

The number of obstructions to navigation of Lower Red River exposed during the period of low water was so great that it was improbable that the *Wagner* could accomplish all that should be done before a rise, and the U. S. snag boat *John R. Meigs* was sent to aid in the work.

The *Meigs*, P. R. Starr, master, left Vicksburg Sunday, September 27, 1896, entered Red River the next day, and commenced work at the head of Atchafalaya the morning of the 29th. On sounding the bar just above Black River only 20 inches depth was found, and a brush dam 75 feet long was built to concentrate the flow and scour the bar sufficiently to enable the boat to pass up. The dam was completed October 1, lines were laid, and the boat backed over the bar in three hours' time. Three days later, at about the same stage, the snag boat *Wagner* found 3 feet depth on the bar. Above the mouth of Black River to Natchitoches Bayou, at head of Grand Point, tree slides in the channel were almost continuous. The heavy growth of timber along shore had pushed and slid into the river, forcing the unbalanced bottom up in large mud lumps, many of which were covered with logs and stumps, which were pulled out, cut up, or destroyed with dynamite. At head of Natchitoches Bayou a tremendous jam of trees, logs, and stumps, 40 feet high in places, had formed, and sand and mud had deposited over it to such an extent that it was impossible to destroy the drift by burning. As there was no place to deposit the débris, if pulled out, all the long logs and trees were cut up, so they would float away at a moderately high stage.

October 30 the commercial steamboat *W. T. Scovell* with two barges in tow passed up from New Orleans, being the first Red River boat since the latter part of August. The officers expressed their gratification at the work done by the *Wagner* and *Meigs* in the lower river, and reported that the *Scovell* ran Grand Point after night, never before attempted at so low a stage.

Through the Rapious ample depth was found, but the channel was contracted and irregular, on account of mud lumps covered by water, which the snag boat could not destroy. All snags, logs, and stumps in the channel that had scoured so they could be located since the *Wagner* passed down were removed, and also shore snags, sliding trees, and stumps along the banks. At Bordelon Bend the river had divided in two channels with a sand-bar between. Brush being inaccessible, the right chute was closed by a dam 150 feet long, built of 1,561 sacks filled with sand, which forced the water to the left of the bar and soon scoured to a depth of 4 feet.

At Snaggy Point a number of snags and logs were removed from the channel, but in crossing the lower bar November 24 the boat grounded and its head swung into bank. A line was laid and the steam capstans started, to pull it off. A surge of the capstan caused the line to slip, and it struck Master Laborer Herman Schulz and one laborer knocking both overboard. They were rescued promptly from the river, but Master Laborer Schulz's right arm was broken, and he died in a few minutes from the effect of the shock. The laborer was not injured seriously.

Work of the *Meigs* continued upstream to Alexandria, which was reached December 8. A slight rise of the river and the efficient work of the snag boats *Howell* and *Wagner* a few months before left little to be done above Snaggy Point beyond the removal of leaning timber on points, in bends, and where the banks were caving.

The capstan machinery needing repairs after the hard season's work, the *Meigs* left Alexandria December 9 and returned to Vicksburg December 13.

The following is a summary of the work done by the *Meigs* September 29–December 8, 1896, viz:

Snags pulled	309
Stumps pulled	996
Stumps cut and destroyed	4,690
Shore snags cut	4,599
Logs removed from channel	237
Leaning trees cut	41,089
Trees girdled	216
Square yards willows and brush cut	578
Wing dams built	2
Aggregate length 225 feet.	

To take advantage of the continued low stage of Red River, a party equipped with axes, saws, explosives, tackle, etc., was organized by master laborer E. P. Allen at Shreveport, La., for work in the river above that place. October 10–13, 1896, a small quarter boat, laid up in Cross Bayou at Shreveport, was pulled about 1,200 feet across the bar to Red River, fitted up, and outfit and supplies placed aboard. Work commenced October 14, about a mile above Shreveport, and between that date and January 22, 1897, it was carried upstream 65 miles to Head of Raft, La. January 23–February 5 the party worked back to Shreveport.

Stumps near edges of banks were cut out and roots removed; shore snags were cut close to the banks; leaning and sliding trees were felled, trimmed, and cut into lengths of 12 to 16 feet, and stumps and snags in the channel were destroyed, as far as practicable, with explosives. Logs and drift which had lodged on bars and tow heads, or in shoal water, were destroyed or chopped up so they would float out on first rise; side jams were cut up and started adrift, and tow head formations were blown up. On the way up, while the water was lowest, no work was done on top banks except where they were caving, operations being pushed as rapidly as possible to get over the worst stretches before a rise, with the intention of doing what was necessary along the upper banks on the way back at a higher stage.

The following is a summary of the work done by the shore party October 14, 1896–February 5, 1897, viz:

Channel snags destroyed	333
Stumps cut and destroyed	3,601
Shore snags cut	25,902
Side jams removed	147
Logs cut up	511
Tow heads blasted	15
Leaning trees felled	13,426
Square yards willows and brush cut	3,050

Cold print and arrays of figures fail to express the vast amount of hard work accomplished by the three snag boats and the shore party during the year. The illustration opposite page 1908, Report Chief of Engineers for 1893, gives an idea of a jam of drift in Upper Red River, and how difficult its removal would be should the water fall. As the bottom of the river scours and lowers stumps appear at low stages, similar to those shown in the illustration immediately preceding page 1909 of the same report. Stumps of this character are removed from the bottom every year, but as the scour continues others are uncovered and brought to the surface at times at the same locality.

The enormous quantities of drift borne by Red River at flood; the shifting and changing of the channel, uncovering snags, logs, and stumps, and the caving and sliding banks will necessitate continuance of snagging operations for many years, or until the source of drift is stopped by clearing the banks for some distance back and the channel fully cleared of obstructions, the banks fixed, and the floods restrained by a substantial system of levees.

ALEXANDRIA.

A resurvey of Alexandria Reach was made by Assistant Engineer T. C. Thomas, September 12–19, 1896, with a view to resuming dredging operations, and October 19–27 Assistant John Hilleke was employed in laying out ranges, etc.

The U. S. dredge, *Lone Star*, and barges were put in readiness for work, and dredging at foot of Upper Falls was resumed October 29, 1896, and continued until January 10, 1897. Engineer George W. Phillips, who had been in charge of the dredge for five years, died suddenly November 19, and Overseer Robert Elflein was sent from Vicksburg, November 24, to take local charge of the work.

Operations consisted of widening and straightening the dredged cut on the east side, below, under, and above the Missouri Pacific Railway Bridge, and were continued until high water prevented reaching bottom with the dipper. Two cuts, each 25 feet wide, the first about 450 feet and the second about 240 feet long, were made. The second cut was not completed under and above the bridge on account of the rise, but was carried as near that structure as the dredge could operate on the stage. January 7–9 were spent in beginning a third cut at the lower end, which was carried upstream 86 feet until the water got too high for work.

Before commencing work the rock bottom was broken up with explosives, to facilitate dredging. The material excavated from the channel was deposited on barges, which were cordeled to the west bank and the rock shoveled off within the limits laid out.

The following is a summary of the work done October 29–January 9, viz:

Cubic yards of rock excavated from channel	4,951
Number of barge loads moved to and deposited along west bank	211

Although unfinished, the work has benefited low-water navigation by permitting steamboats to make a straight run up the east side of the drawspan of the bridge, where formerly they had to take an irregular course, first steering toward the protection pier and then back to the east side.

CONSTRUCTION OF LEVEES.

No levee work was undertaken by the United States during the year.

The estimates for levee construction submitted in my report of 1895 amounted to $450,000, and the total appropriation, to cover all expenditures of two years, by the act of June 3, 1896, was $100,000. The system of levees begun in 1893 in conjunction with work of the State of Louisiana and local levee boards had to June 30, 1896, aggregated about 105 miles of new levees and 70 miles of enlargement, requiring nearly 6,500,000 cubic yards of earthwork which cost in the neighborhood of $960,000. The proportion of this work built by the United States was about 15 per cent, with a similar relative proportion of cost.

While the work of the United States is intended as part of a system to improve navigation, that of the State engineers and levee boards is for direct protection of fertile lands from overflow. The allotments heretofore made from appropriations for improving Red River represent a comparatively small percentage of the cost of the work done, but they have served to direct action of the State engineers to no small extent in planning their portions of the system, and if operations could be continued in the same way for a few years that portion of the system within Caddo and Bossier districts could be completed at a relatively moderate charge to the United States. The people of these districts, however, have taxed themselves for levees almost to impoverishment and their means are about exhausted for the present.

So far no assistance has been given to the district below Alexandria, and it is only fair that it should be done as early as possible for the benefit of people who are contributing directly to improvement of the lower river. Limited funds and urgent calls from various sources render it difficult to decide where expenditures shall be made to result in greatest advantage to navigation. People above the upper limit of the present system have applied for levee work in Arkansas, but so far as the improvement of Red River is concerned levees are not required above the hills at Blanton Bluffs at the present time. It should be stated also that the State engineers of Louisiana, when they built the levee from Sale and Murphy Dam northward to Blanton Bluffs in 1891-92, were compelled to provide means for extending the line above the limits of their own State into Arkansas, and that the same conditions occurred along Mississippi River.

The completion of the line in Caddo Parish, La., from Sale and Murphy Dam to the Coushatta and Hervey Canal Levee, built by the United States in 1896, was considered of first importance, and June 6, 1896, I wrote Assistant State Engineer F. M. Kerr, who has charge of the Red River work under the board of State engineers, asking if ways could be devised by which the State and the Caddo Levee board could join with the United States in closing the gap. In reply he stated:

> In regard to the ability of the Bossier and Caddo Levee boards at this time to join with the State and the United States in undertaking further levee work in the districts there is unfortunately but one answer to make: That to accomplish the work of first necessity both districts have strained their resources to such an extent in the last four years that it is absolutely necessary for them for some time to come to confine their expenditures to a minimum in order to avoid irreparably crippling their resources. Even by assessing all the taxes permitted by law, which both boards have readily and uniformly done, the resources of the districts are at best very limited. But in spite of this fact the levee work executed by the Caddo and Bossier Levee boards alone in the past four years foots up the creditable aggregate of about 3,000,000 cubic yards, which, with total possible resources within the same period of $600,000, including $400,000 thirty-year 6 per cent bonds, for which $24,000 must annually be set aside for interest, readily warrants the claim that the boards have earned a well-merited breathing spell to enable them to devise ways and means to meet the heavy obligations for the liquidation of which they have been compelled to hypothecate the entire revenues of the districts for future years.
>
> The State funds available for levee work in Caddo and Bossier parishes this year will probably amount to about the usual sum applied in those districts, say $30,000. It is, however, the opinion of this Board that the State funds should not at this time be applied in bulk to any one locality but be held in reserve to keep

> intact and preserve as far as possible the line of public levee as it now exists, much of which is still lower in grade and smaller in section than is believed to be necessary to insure an equal degree of security to all parts of the district, and many parts of which are more or less threatened by breaches from caving banks. From which you will readily understand that we could not at this time recommend the allotment of any part of the State fund to the work of closing the gap between Red Bayou and Sale and Murphy Canal.

After a subsequent conference the board of State engineers caused a survey to be made and the proposed line located from the upper end of Coushatta and Hervey Canal Levee to the Sale and Murphy Dam. The survey was completed the latter part of August, 1896, and showed the amount of embankment required to be about 736,000 cubic yards. The country is a difficult one for construction, and the cost of the work, even under the most favorable conditions, will be far beyond any sum that might be allotted by the United States from available funds.

A statement of levee work on Red River done by the State of Louisiana during the year is appended.

Statement showing levee work on Red River, undertaken by the State of Louisiana, from July 1, 1896, to June 30, 1897.

[Prepared by request for Maj. J. H. Willard, Corps of Engineers, U. S. A.]

Name of contract.	Parish.	Below Fulton.	Date of—		New levee.	Enlargement.	Quantity.	Price per cubic yard.	Cost.	Per cent of work done.
			Contract.	Final certificate.						
Caddo Levee district.		*Miles.*			*Linear feet.*	*Linear feet.*	*Cu. yards.*	*Cents.*		
Rush Point	Caddo	152.5 -155	Sept. 14, 1896	Nov. 23, 1896		11,900	32,589	10.20	$3,324.07	100
Dixie (includes work at Dixie, Eagle Bend, and Kentucky).	do	195.5 -199.5	do	Mar. 8, 1897	2,808	11,676	79,784	8.89	7,092.79	100
Riverdale (Long Point section)	do	210.5 -212.5	Nov. 4, 1896	Not issued		8,565	31,224	9.74	3,041.21	100
Magnolia	do	226 -227.75	Sept. 14, 1896	Dec. 22, 1896	4,815	1,085	40,003	7.23	2,892.21	100
Total					7,623	33,226	183,600		16,350.28	
Bossier Levee district.										
Buck Hall and Cash Point	Bossier	173 -173.75 175 -176	Sept. 14, 1896	Nov. 13, 1896	3,825	5,075	37,823	9.125	3,451.34	100
Pandora (includes work at Pandora, Benoit Bayou, Hollingsworth, and Sunflower).	do	176.75-181	do	Feb. 26, 1897	10,605	4,740	113,132	8.125	9,191.97	100
Magenta to Knox Point	do	214.75-224.5	Dec. 2, 1896	Mar. 15, 1897		21,362	54,125	9.48	5,131.05	100
Total					14,430	31,177	205,080		17,774.36	
Red River, Atchafalaya, and Bayou Boeuf Levee district.										
Alexandria (includes work at Alexandria and Sandy Bayou).	Rapides	397.5 -398 and 400.5	Aug. 31, 1896	Oct. 27, 1896	128	3,495	22,894	15.75	3,605.80	100
Cut-off Bayou to Ashton	do	402.5 -403.75	Oct. 26, 1896	Jan. 27, 1897	521	6,834	49,613	7	3,472.91	100
Overton (includes work at Overton and Sunny Home).	Avoyelles Rapides	430.5 -432.75 420.25	do	May 24, 1897	5,360	5,700	75,801	8.73	6,617.42	100
Total					6,009	16,029	148,308		13,696.13	
					28,062	80,432	536,988		47,820.77	

Total work undertaken: New levee, 5.31 miles; enlargement, 15.23 miles.

In addition to the foregoing, the Red River, Atchafalaya, and Bayou Boeuf Levee district raised and enlarged Neilson and Scotland levees in the parish of St. Landry on the west bank of the Atchafalaya River, aggregating 3,151 feet in length, containing 17,007 cubic yards of earth work, and costing $2,035.73. The district also spent about $20,000 in maintaining its levee line on Bayou des Glaizes and the Atchafalaya River during the high water of 1897.

The Caddo and Bossier Levee districts were unable to undertake any other work than that of administration during the period named.

The State of Louisiana has at this time a "Notice to Levee Contractors" advertised in the Official Journal of the State inviting proposals to build the Belleview Levee, in the parish of Rapides, about 2 miles below Alexandria. The work will be about 1 mile long, and contain about 50,000 cubic yards.

Respectfully,

THE BOARD OF STATE ENGINEERS,
Per F. M. KERR, *Assistant State Engineer.*

OFFICE BOARD OF STATE ENGINEERS, *New Orleans, La., June 17, 1897.*

SULPHUR RIVER.

Work in this tributary of Red River, which was in progress at close of the fiscal year ending June 30, 1896, was continued July 1–6, 1896, by the crew of the U. S. snag boat *Howell*. A supply of dynamite having been delivered, the stretch of about 8 miles from the mouth to Fort Lynn was worked over the second time, at the lowest stage of record. It being impracticable to operate the snag boat at the low stage, and urgent calls having been made for work in Lower Red River, the *Howell* left for Shreveport July 7.

January 12–30, 1897, the snag boat *Howell* was employed in the stream again. On entering there was a strong inflow from Red River, and as the drag chain could not be used with the current, the boat ran in with the intention of working back. The Texarkana and Shreveport Railroad Bridge at Fort Lynn was found jammed with drift, which could not be moved until a fall of Red River sufficient to reverse the current, and the *Howell* worked back to the mouth, dragging the channel for snags and logs, removing leaning timber, etc. On the night of January 15 the current began running out, and in the succeeding two days the jam at the bridge was cleared. January 18–22 work was carried upstream to the Kansas City, Pittsburg and Gulf Railroad Bridge, about one-fourth mile east of the Texas line, and January 23–30 back to Red River; signboards having been erected to mark the channel through the lakes. January 31 the *Howell* returned to Shreveport, La.

The following is a summary of the work done in Sulphur River in July and January, viz:

Snags and logs removed from channel	1,238
Stumps pulled, cut, and blown up	475
Jams removed	5
Side jams removed	5
Leaning trees cut	5,143
Trees girdled	20
Signboards erected, to mark channel through lakes	36

This work put the stream in fair navigable condition at ordinary stages.

GENERAL REMARKS.

The subject of the general improvement of Red River was discussed somewhat at length in my report for 1894 (Report Chief of Engineers, 1894, p. 1430), and the opinions therein expressed are still held. But the great development of hydraulic dredging, under the Mississippi River Commission, may lead to the use of a similar plant on a small scale in streams of this class. The experiment could be made at moderate cost by setting up a portable centrifugal pump and engine on one of the large snag boats, and attacking some of the bars on wide reaches. Perhaps a better plan would be to build a barge and fit up as a dredge, with the exception of boilers, taking steam from the snag boat or tender required to tow it to the place of operations. Then if the experiments should justify this class of work, a steamboat dredge might be built specially for the purpose.

In the meantime there are two classes of work that should be provided for by liberal appropriations—the snag-boat service and the extension of the levee system. For the former, with the most rigid economy, the allotments which have been made during the past six years have been about right, but the plant is growing old and the wear and tear is great, so that a liberal allowance must be made for repairs, or new boats will have to be built within a few years. The *Howell* was built in 1880, and should have a new bottom; the *Florence* was rebuilt in 1884, and is now worn very thin. New quarterboats and barges are required, and boats with small engines or capstans for shore parties.

Owing to the dangers from snags and logs in the bed of the river, all large craft should be built of steel, not only because disasters to wooden boats are generally complete, but because steel boats (except for extensive repairs) can be repaired by the crew without going to dry docks.

For levee work, the most important is the completion of the upper section of the Caddo system between the upper end of that last built by the United States below Herveys Canal and the State line from the Arkansas Hills at Missionary ending on the dam built by the United States across Sale and Murphy Canal.

The yardage given by Assistant State Engineer Kerr, as already stated, is about 736,000 cubic yards, but this should be increased, in my opinion, both because greater height should be given on account of the distance from Shreveport, and to allow for greater height of floods due to closing the bayous and canals on the right bank, and finally because more banquette work should be required than first thought needful. I consider 800,000 cubic yards as the least amount consistent with safety, and 25 cents per cubic yard as the least price that will insure a successful completion of the work. The amount is so large that the work should be divided into at least four sections for contract. Not less than $50,000 should be set apart for enlargement and for extension from the lower end of State levees in Caddo Parish to Shreveport; the same amount for the Tones Bayou dams; $200,000 for the Bossier district, above and below Shreveport; and $50,000 for the Red River, Atchafalaya, and Bayou Bœuf district. Demands have been made for assistance in reaches above the Arkansas State line, but nothing should be recommended until the State of Arkansas takes the initiative, either through its own officers or by the creation of levee districts, so that the work may be done under a system and not for private purposes.

The work done by the United States in Arkansas near Missionary was a matter of necessity in order to connect the Caddo system with high ground at Blanton Bluff, and was not intended as a precedent for extending levee work into Arkansas without assistance or cooperation with the State. The experience of the last flood in the Mississippi River has demonstrated the need of stringent laws in regard to the abuse of levees, and as the subject is likely to be taken up seriously by Congress at the next session, it is hoped that the legislation in regard to care and protection of levees may be made general.

ESTIMATES.

Addition to plant	$50,000
Care of plant and ordinary repairs	15,000
New bottom for snag boat *Howell*	10,000
New bottom for snag boat *Florence*	5,000
Service of plant, snag boats, etc	50,000
Levees	550,000
Local surveys, maps, and gauges	10,000
Administration and contingencies	5,000
Continuing snagging operations, etc., above Fulton	5,000
Total	700,000

Money statement.

July 1, 1896, balance unexpended	$137,997.86
June 30, 1897, amount expended during fiscal year	37,974.25
July 1, 1897, balance unexpended	100,023.61
July 1, 1897, outstanding liabilities	54.37
July 1, 1897, balance available	99,969.24
Amount that can be profitably expended in fiscal year ending June 30, 1899	700,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

The amounts expended during the year and balances July 1, 1897, are as follows:

Allotments.	Expended during year.	Balances July 1, 1897.
For general improvement, repairs, care of plant, etc	$29,602.15	$20,404.94
For Little River from Scopini Cut-off to Knox Point (act September 19, 1890).	1,116.65	10,000.72
For work at Alexandria, La	6,129.38	3,574.25
For construction of levees	54.50	63,382.69
For Sulphur River	981.57	2,661.01
Total	37,974.25	100,023.61

The appropriations for the early work, from 1828 to 1852, were as follows:

Date of act.	General object of appropriation.	Amount.
May 23, 1828	Improving navigation of Red River through or around the raft in Louisiana and Arkansas	$25,000.00
Mar. 2, 1831	Arrearage due Major Burch for survey of raft of Red River, Louisiana	187.50
July 3, 1832	Improving navigation of Red River, Louisiana and Arkansas, being balance of appropriation of 1828 carried to surplus fund, and the further sum of $20,000	22,628.00
June 28, 1834	Improving navigation of Red River	50,000.00
Mar. 3, 1835	Completing removal of obstructions to navigation of Red River	50,000.00
July 2, 1836	Continuing the removal of obstructions in Red River	40,800.00
	Constructing a boat to prevent a new accumulation of obstructions in Red River within the old limits of the great raft, $15,000, and to work and support same, $15,000	30,000.00
Mar. 3, 1837	Continuing the removal of obstructions in Red River	65,000.00
Apr. 20, 1838	The complete removal of the great raft in Red River	70,000.00
Mar. 3, 1841	Removing the raft of Red River	75,000.00
Mar. 2, 1847	Deficiency of appropriation by act of April 20, 1838, being amount advanced by Daniel T. Witlee and others, through the branch of the Real Estate Bank of Washington, Ark., to Henry M. Shreve, Government agent, for removal of great raft, and expended by him for that purpose	7,150.00
Aug. 30, 1852	Removing the raft of Red River	100,000.00
	Aggregate of appropriations, 1828-1852	535,765.50
	Amount expended	532,219.90
	Amount carried to surplus fund	3,545.60

The appropriations since 1872 have been as follows:

Date of act.	General object of appropriation.	Amount.
June 10, 1872	Improvement of Tones Bayou, Louisiana	$20,000
	Removing the raft in Red River, Louisiana	150,000
Mar. 3, 1873	.....do	80,000
June 23, 1874	.....do	50,000
Mar. 3, 1875	.....do	20,000
Aug. 14, 1876	Removing the raft in Red River and closing Tones Bayou	35,000
Apr. 10, 1869	Allotment made August 27, 1877, for closing Tones Bayou	4,500
Feb. 7, 1878	Opening navigation of Red River above Shreveport, La., and keeping same open and free from rafts, and for the purpose of preserving vessels of United States employed in that work	6,000
June 18, 1878	Removing raft in Red River and closing Tones Bayou	24,000
	Removing snags and other obstructions from Red River	25,000
Mar. 3, 1879	Removing raft in Red River and closing Tones Bayou	15,000
	Removing obstructions from Red River	22,500
	Improving upper Red River, Arkansas, from Fulton to head of the raft	10,000
June 14, 1880	Removing raft in Red River and closing Tones Bayou	25,000
	Removing obstructions from Red River, Louisiana, including construction of snag boat	60,000
	Improving Upper Red River, Arkansas, from Fulton to head of the raft	10,000
Mar. 3, 1881	Removing raft in Red River and closing Tones Bayou	10,000
	Removing obstructions from Red River, Louisiana	10,000
Aug. 2, 1882	Continuing improvement from the Atchafalaya to Fulton, Ark., including Bayou Pierre, Tones Bayou, and to relieve the town of Alexandria from encroachments of the river	75,000
July 5, 1884	Continuing improvement from the Atchafalaya to Fulton, Ark.; not exceeding $15,000 for revetment to protect the harbor at Alexandria from damage by the current of river; not exceeding $5,000 to close the outlet known as Sale and Murphy Canal; the remainder to be applied to improvement of the main channel of the river	75,000
Aug. 5, 1886	Continuing improvement from Fulton, Ark., to the Atchafalaya River, Louisiana, including completing the work at Alexandria; $25,000, or so much thereof as necessary, to be used in making a thorough survey of the river from Fulton to the Atchafalaya and in completing survey of Bayou Pierre, Louisiana	75,000
Aug. 11, 1888	Continuing improvement from Fulton, Ark., to the Atchafalaya River, including completing the work at Alexandria; $5,000, or so much thereof as necessary, to be used upon Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex., and $5,000, or so much thereof as necessary, upon Bayou Dorcheat	65,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	35,000
Sept. 19, 1890	Continuing improvement from Fulton, Ark., to the Atchafalaya River; $15,000 to be used in the work at Alexandria; $20,000 to be used in deepening and widening that portion known as Little River, from the Scopini Cut-off to Knox Point, and $5,000 in closing the Sale and Murphy Outlet.	100,000
	Completion of survey from Fulton, Ark., to the Atchafalaya River	28,000
July 13, 1892	Continuing improvement from Fulton, Ark., to the Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey, including the work at Alexandria, the widening of that portion known as Little River, the necessary work at the harbor at Shreveport, the closing of outlets on the west bank of the river above Shreveport, and the removal of the towhead just above Rush Point, Caddo Parish (of which $5,000 may be used, in the discretion of the Secretary of War, for work in Cypress Bayou and the lakes between Shreveport, La., and Jefferson, Tex.)	145,000
Aug. 18, 1894	Continuing improvement from Fulton, Ark., to Atchafalaya River, according to plan of Capt. J. H. Willard, Corps of Engineers, and for completion of survey; $15,000, or so much thereof as necessary, to be used in further prosecution of work at Alexandria, and $5,000 for improving Sulphur River, a tributary of Red River	150,000
June 3, 1896	Continuing improvement from Fulton, Ark., to Atchafalaya River	100,000
	Aggregate of appropriations, 1872 to 1897	1,425,000

COMMERCIAL STATISTICS.

The river was reported navigable in the fiscal year as follows: From Shreveport to Fulton for light-draft boats the entire year. Below Shreveport navigation was suspended for a period of thirty days during low water in September and October. The mouth of Red River was navigable the entire year.

List of steamboats engaged in the trade during the fiscal year 1897.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
Imperial	Stern-wheel.	494.69	210	40.6	6.6	3 0	8 0	New Orleans and— Shreveport Coushatta Cane River Montgomery	 7 1 1 1	184
Valley Queen	...do	410.83	190.6	35.8	5.6	3 0	8 0	New Orleans and— Shreveport Lake End Coushatta	 8 2 1	189
Hallette	...do	265.9	161	30.5	4.5	2 0	6 0	New Orleans and— Shreveport Coushatta Knox Point Lake End Last Chance Cassiola Tessier	 11 1 1 1 1 1 1	161
W. T. Scovell	...do	154.23	160	31	3.7	1 10	5 6	New Orleans and— Shreveport Coushatta Montgomery Natchitoches Alexandria Colfax Iola	 12 3 5 2 1 1 1	184
Anna B. Adams	...do	315.49	157	31.6	3.1	1 6	4 0	New Orleans and— Shreveport Montgomery Shreveport, Garland, and Alexandria.	 1 2 8	30
Rosa Bland	...do	64.01	113.2	22.8	4.4	1 6	4 0	Shreveport and— Garland Coushatta Jefferson	 33 17 3	 66 12 10
Des Arcs *a*	...do	40.88	95	18	3	1 6	3 0	Lake End, Colfax, and Grand Ecore.	40	......
H. W. Graves *a*	...do	31.22	94.6	17.6	3	1 4	3 0	Campti and local landings above and below.	49	......
G. W. Mayo	...do	79.56	109	20	2.5	1 4	3 0	Fulton and various landings below.	21	300
Jo. Walker	...do	59.48	80.4	20	3	1 0	2 6	Shreveport and Whitehall.	30	......
Bessie Siler *a*	...do	49.38	93	16	3	2 0	2 6	Montgomery and mouth Red River.	50	......
Nellie L. *a*	...do	......	......	......	......	1 10	3 6	Jefferson and Shreveport.	2	......
Undine *a*	...do	15	56	9.5	3.1	1 6	2 6	Garland and— Fulton Conway	 1 24	 ....
G. W. Lyon *b*	...do	86.17	115	22	4.4	......	......	New Orleans and Red River.	2	......
George L. Bass *b*	...do	53.82	91	21	3.3	1 6	3 6	New Orleans and Alexandria.	1	......
Occola *a*	...do	24.39	70.6	15.2	2.9	1 2	3 0	Local towing above and below Alexandria.	....	......
Lee Otis *a*	Tug	10	40	9	5	4 6	4 6	Alexandria and mouth Red River.	100	108

a With one or more barges. *b* Towboats.

Summary of commerce reported.

Articles.	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	15,941	13,204	18,308	15,392	14,061	29,400	21,613	18,838
Cotton seed	26,962	18,537	5,322	4,402	7,902	31,832	12,249	14,140
Cotton-seed meal	9,633	4,822	4,516	9,042	4,713	....	10,000	....
Live stock	15	55	49	496	1,185	286	38	....
Hides and skins	80	71	50	31	62	151	212	35
Lumber	643	1,570	1,657	1,257	1,520	2,352	....	4,519
Saw logs	12,885	18	20,000	28,869	15,200	22,250	16,523	....
Staves	4,084	380	697	228	1,789	206	81	58
Miscellaneous	1,770	2,285	3,000	105,395	5,964	14,107	2,719	136
Total, down freight	72,013	40,942	53,599	165,112	52,346	100,584	63,435	37,726
Return freight	39,851	32,560	22,122	63,518	17,605	19,942	30,051	28,650
Total	111,864	73,502	75,721	228,630	69,951	120,526	93,486	66,376
Estimated value	$4,429,000	$3,833,000	$3,419,000	$6,061,000	$3,422,000	$6,877,000	$9,185,000	$6,820,000

In addition to the above, from Ouachita River entering Red River at mouth of Black River, 229,250 tons, the value of which is estimated at $5,722,000.

Receipts and shipments of bales of cotton at Shreveport, La.

	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
RECEIPTS.								
By rail	66,666	42,860	52,573	30,033	25,277	44,256	39,890	25,476
By wagon	31,768	31,474	54,968	41,014	31,612	49,644	37,725	40,026
By river	4,611	6,679	11,319	5,581	4,821	9,189	14,836	8,897
Warehouse receipts	103,045	81,013	118,860	76,628	61,710	103,089	92,451	74,399
SHIPMENTS.								
By Texas and Pacific Rwy	31,618	22,631	34,239	25,019	26,904	36,645	23,311	23,690
By Vicksburg, Shreveport and Pacific R. R	12,191	10,441	20,239	10,546	10,384	23,251	15,564	20,813
By Houston and Shreveport R. R.	17,660	16,582	22,459	13,429	3,114	5,353	13,860	12,529
By St. Louis Southwestern Rwy	20,230	16,869	28,469	17,817	7,818	24,187	15,039	8,820
By Kansas City, Pittsburg and Gulf R. R	16,672	100	....	....	....	....	....	....
By river to New Orleans	8,327	14,102	10,654	9,246	14,751	10,567	19,218	8,412
Total	106,698	80,725	116,060	76,057	62,971	100,003	86,992	74,264

The competing routes of transportation for the trade of Red River Valley, below Fulton, Ark., are as follows: The river is crossed by the St. Louis, Iron Mountain and Southern Railway at Fulton, Ark., by the St. Louis Southwestern Railway (Cotton Belt route) at Garland, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Shreveport, La., and a branch of the Cotton Belt system from Lewisville, Ark., 8 miles east of Garland, runs parallel to the river to Shreveport. The Texas and Pacific Railway runs nearly parallel to the river and touches at Alexandria, Boyce, Shreveport, and other points on the main river, and at Jefferson, Tex., on Cypress Bayou, and connects at Texarkana, Ark., with the Cotton Belt and St. Louis, Iron Mountain and Southern. Morgan's Louisiana and Texas Railroad, a branch of the Southern Pacific, runs from Alexandria to the main line. Shreveport is the eastern terminus of the Houston and Shreveport Railroad. The Houston, Central Arkansas and Northern Railroad, a branch of the Missouri Pacific system, crosses the river about 1¼ miles above Alexandria. The Kansas City, Watkins and Gulf Railway runs from Lake Charles, La., on the Southern Pacific, to Alexandria, and is building eastward to Natchez, Miss., and another line is projected to cross at Alexandria. Jefferson, Tex., at the head of navigation of Cypress Bayou, has transportation by the Missouri, Kansas and Texas Railway, in addition to the Texas and Pacific Railway mentioned above. The Texarkana and Shreveport Railroad is built from Texarkana south 34 miles to Kiblah, Ark. The Kansas City, Pittsburg and Gulf Railroad, from Kansas City, Mo., to Port Arthur, Tex., crosses the river north of Texarkana and touches at Shreveport. Branches of this road are contemplated from Shreveport to Coushatta and Natchitoches, La., along Red River, and from Mooringsport, La., to Jefferson, Tex., at head of Cypress Bayou.

U 2.

IMPROVEMENT OF RED RIVER ABOVE FULTON, ARKANSAS.

No work was done in this part of Red River during the fiscal year ending June 30, 1897.

The project submitted June 23, 1896, and approved July 8, 1896, and my last annual report, contained the following plan for expenditure of the available funds, viz:

> The act of June 3, 1896, provided only $3,000 for continuing improvement of Red River above Fulton. There is no plant belonging to this work, and it can not be let advantageously by contract. I can devise no plan by which the appropriation can be expended with greater economy and advantage to the United States than the following: When one of the snag boats is employed near Fulton, it is proposed to continue operations above that place as far as the boat may be able to work, to mouth of Kiamichi River if practicable, and, if driven out by a falling river, to resume operations from time to time as circumstances will permit; the plan being that instead of ceasing snagging operations at Fulton, under the project for improving Red River from Fulton to the Atchafalaya, they shall continue above that place until the appropriation is exhausted. Local navigation will be benefited, but the chief gain is to the river below, in reducing the amount of drift. The improvement is worthy to be continued in this manner, but it is recommended that it be done hereafter by allotment from the appropriation for Red River, Louisiana and Arkansas, instead of a separate item of appropriation, and for these reasons the estimate for its continuance is included in the report for that work.

The U. S. snag boat *C. W. Howell* reached Fulton from below March 6, 1896, with the intention of continuing operations upstream, but had to undergo certain repairs of iron bottom, which were not finished until March 22. By that time the river had reached a stage of 28.5 feet, rising, on the Fulton gauge, which prevented carrying out the plan for the time.

Money statement.

July 1, 1896, balance unexpended	$3,940.44
July 1, 1897, balance unexpended	3,940.44

The appropriations have been as follows:

By act of—		By act of—	
August 5, 1886	$7,000	August 18, 1894	$3,500
August 11, 1888	3,000	June 3, 1896	3,000
September 19, 1890	2,000		
July 13, 1892	3,500	Total	22,000

COMMERCIAL STATISTICS.

The commerce for the fiscal year was confined to saw logs and oak staves, rafted and flat-boated to three sawmills and one stave-factory at Fulton, Ark., as follows:

	Tons.	Value.
Saw logs	12,800	$44,800
Oak staves	2,287	7,120
Total	15,087	51,920

The river, from the mouth of Kiamichi, the upper limit of the improvement, to Fulton, is paralleled by a branch of the Texas and Pacific Railroad from Texarkana to Paris, Tex., connecting at the latter place with the St. Louis and San Francisco Railway, a branch of the Atchison, Topeka and Santa Fe system, which crosses Red River at Arthur, Tex. The Kansas City, Pittsburg and Gulf Railroad crosses the river about ten miles north of Texarkana, and has a branch from Wilton to White Cliffs, Ark., on Little River, a distance of 7 miles, and the St. Louis, Iron Mountain and Southern Railway crosses at Fulton, Ark.

U 3.

IMPROVEMENT OF CYPRESS BAYOU, TEXAS AND LOUISIANA.

The sum of $15,000 is available for this work, of which $10,000 was appropriated by river and harbor act of August 18, 1894, "for dredging and removing obstructions and straightening channel between Jefferson, Tex., and Shreveport, La.," and $5,000 by act of June 3, 1896, for "continuing improvement."

June 24, 1896, I submitted the following project for expenditure of the available funds, viz:

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 24, 1896.

GENERAL: In compliance with directions contained in letter from your office, dated 19th instant, I have the honor to submit the following project for expenditure of the appropriation by river and harbor act of June 3, 1896, of $5,000 for continuing improvement of Cypress Bayou, Texas.

The title "Improving Cypress Bayou" covers the entire waterway from Jefferson, Tex., down Cypress Bayou, across Fairy and Sodo lakes, and through Twelve-Mile Bayou to Red River, near Shreveport, La. Evidently it was an unnavigable stream until the advance of the Red River raft above Shreveport converted its bottom lands into reservoirs known as Fairy, Sodo, and Cross lakes. Before work for its improvement commenced navigation was difficult and dangerous, on account of bars and leaning timber in the bayou proper, and snags, stumps, fallen timber, and sunken logs in the channel across the lakes. A project adopted in 1872 contemplated straightening the channel and dredging bars in Cypress Bayou, to give uniform depth, and the removal of overhanging trees, shore snags, etc.; opening and enlarging the entrance of the bayou into the head of Fairy Lake by dredging; removing snags, stumps, sunken logs, and timber from the channel selected down the lakes; and snags, leaning trees, etc., in Twelve-Mile Bayou. This project was completed in 1880 at a cost of $94,000; but, owing to the temporary nature of the work, it had to be renewed at intervals to maintain what had been accomplished, nearly $25,000 having been expended for this purpose. The last work, for removal of stumps, snags, and leaning timber, was done in 1893. No dredging has been done since 1888.

The removal of the Red River raft and the closure of outlets along the right bank of Red River reduced the water supply, caused the lakes to drain more rapidly, and shortened the period of navigation between Shreveport and Jefferson. To determine if navigation might be improved permanently by locks and dams, an extended survey was authorized by Congress, and completed in 1893 at a cost of $12,000. Final report upon the survey contained a plan for building a dam with waste weir across Sodo Lake, with entrance from Red River through Cottonwood Bayou by a lock with double gates. The cost of the work was estimated at $375,000, and the plan was discussed at length, with reasons for and against its advisability. The limited commerce to be benefited in comparison with the first cost of the work, annual charges of operation and maintenance, and the fact that the probable life of the improvement could not be estimated, rendered the question of the General Government entering upon the project doubtful, to say the least, and this view appears to have been taken by Congress, as the river and harbor act of August 18, 1894, provided $10,000 "for dredging and removing obstructions and straightening channel between Jefferson, Tex., and Shreveport, La." This appropriation appears to have been based upon a paragraph in my report upon the survey, reading as follows:

"Considering the needs of Jefferson alone, I should recommend improving the present channel from Jefferson to mouth of Twelve-Mile Bayou by removing the logs and cypress stumps, widening it by dredging, easing the curves, clearing the banks of the bayou of leaning timber, and marking the channel by clusters of piles, beacons, and buoys. This route would be navigable for boats that could cross the Albany Flats, and since there are no questions of drainage or discharge to be considered, it could be shortened by cut-offs at every practicable place. With the route thus improved, the only danger to navigation would be that of being blown out of the channel by high winds, which, however, could not be avoided even with slack-water navigation."

Work under the appropriation of 1894 has not commenced, as there has been no plant available for the purpose, and the long distances a dredge would have to be towed to and from the work, rendered a contract inexpedient, as large allowances would have to be made for towing, demurrage when not at work, etc., and the price per cubic yard, probably, would not have fallen below 30 cents. A ladder or elevator dredge, of the Bucyrus Company's make, recently purchased at second hand and repaired from the appropriation for Red River, Louisiana and Arkansas, for use in that stream and upon other works of this district, is well adapted for the purpose, and it is the intention to use it upon this work as soon as it can be spared; a reasonable charge for the service to be repaid into the appropriation from which it was purchased. This dredge was used by the New Orleans and Northeastern Railroad Company in building an embankment to replace the trestle and piling across Lake Pontchartrain, and a duplicate dredge was employed in making a cut and embankment through a cypress swamp near New Orleans, called Florida Walk Canal, showing they can handle advantageously just such material as forms the bed of Cypress Bayou and the lakes between Jefferson and the Albany Flats.

For the foregoing reasons it is proposed to apply the $15,000 now available to carrying out the plan given herein, by hired labor; using the Bucyrus dredge to straighten, widen, and shorten the channel, and a snag boat or a force of laborers equipped with axes, saws, and explosives to remove leaning timber, snags, etc.; all the employees to be furnished subsistence and shelter. This method will be most economical and advantageous to the United States.

Your letter of instructions requires me to express my "judgment as to its worthiness" in each case. The opinions expressed in the special report on Cypress Bayou (Report Chief of Engineers, 1893, pp. 2065–2082), and in other reports and letters, appear to be confirmed by events. Since the survey the levee system on Red River above Shreveport has been extended, especially on the right bank where all but one of the outlets or so-called canals have been closed. There is a gap in the Caddo line from Sale and Murphy dam, built by the United States in 1891, and the Red Bayou and Hervey Levee, built by the United States in 1895–96. The Caddo Levee Board and the State engineers have devoted the greater part of their energies to enlarging the levees toward Shreveport, and the Caddo Board have closed Cottonwood Bayou by a large dam and banquet, so that Cypress Bayou and the lakes will receive still less water, except from natural drainage of the basin, unless Red River overflows the natural banks above or rises very high at Shreveport. The closing of the gap and Hervey Canal is now being pressed on this office by the State engineers and levee boards, and the only obstacle to its immediate undertaking is the lack of sufficient money.

Albany Flats are practically bare at extreme low water, and the fall to Shreveport is over 9 meters, say 30 feet, while extreme high water at Shreveport was about 4.6 meters below the highest water of record at Jefferson. Fortunately for the general interest we have not had a dangerous flood in Upper Red River since 1894, although we had a short, sharp flood last summer which caused some uneasiness; and the indications are that scour is still going on and the low-water line falling below Shreveport, showing decided gain in discharge capacity. The people in Jefferson feel that somehow they should be compensated for the loss of water, but this was the natural result of removing the great raft which formerly ponded the river above and caused the surplus to seek the lakes and the bayou through the outlets on right bank. They seem to think that a dredged cut through Albany Flats would solve the problem, but as the flats form a dam a cut would lower the lake surface and drain Cypress Bayou to a still smaller stream. I did not intend my remarks as to the needs of Jefferson in the report of 1893 as a recommendation, though they seem to have been so construed. I have submitted no estimates since then, nor can I find any arguments for further expenditures. Under existing conditions it is not possible to give an open navigation to Jefferson except at very high stages; while if the question of slack-water navigation should be revived an entirely new solution would be required, because Cottonwood Bayou has been closed and the Caddo levee system extended below it. Cypress Bayou and the lakes played their parts as navigable waterways years ago, and were at their best during the raft period when Upper Red River was at its worst. Boats occasionally visit Jefferson at high stages, but commerce has been compelled to seek other and more certain routes to the country formerly supplied by water and of which Jefferson once was the distributing point.

The expenditure of the funds appropriated by Congress will improve the route between Jefferson and Albany Flats, and navigation will be safer and more expeditious when the depth at the flats will admit. The fact that there is a water route available at certain stages should have some influence on railway freights.

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. WILLIAM P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

This project was submitted to the Secretary of War August 18, 1896, with recommendation for approval, and was approved June 14, 1897. Notification of approval was received at this office, through the division engineer, June 22, 1897. As Red River was falling, and soon would be at a stage too low to tow the elevator dredge from Vicksburg to Shreveport, with probability that low stages might continue until January, 1898, the U. S. snag boat *Meigs* left Vicksburg with the dredge in tow June 25, and June 30, 1897, had reached a point on Red River 7 miles above Colfax, La., and 328 miles from Vicksburg.

Money statement.

July 1, 1896, balance unexpended	$15, 186. 92
June 30, 1897, amount expended during fiscal year	619. 17
July 1, 1897, balance unexpended	14, 567. 75
July 1, 1897, outstanding liabilities	7. 80
July 1, 1897, balance available	14, 559. 95

The appropriations for Cypress Bayou and the lakes have been as follows:

By act of—	
June 10, 1872	$10, 000. 00
March 3, 1873	50, 000. 00
August 14, 1876	13, 000. 00
June 18, 1878	15, 000. 00
March 3, 1879	6, 000. 00
August 5, 1886	18, 000. 00
August 11, 1888 (allotted from appropriation for Red River)	5, 000. 00
September 19, 1890, for survey	10, 000. 00
July 13, 1892, for survey	2, 000. 00
July 13, 1892 (allotted from appropriation for Red River)	1, 701. 33
August 18, 1894	10, 000. 00
June 3, 1896	5, 000. 00
Total	145, 701. 33

COMMERCIAL STATISTICS.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	*Feet.*	*Feet*	*Ft. in.*	*Ft. in.*			
Rosa Bland	64. 01	113. 2	22. 8	4. 4	1 6	3 6	Shreveport and Jefferson	3	10
Nellie L					1 10	3 6	Jefferson and Shreveport	2	

Commerce reported.

Cotton	tons..	90
Cotton seed	do...	200
Cotton-seed meal	do...	100
Hides and skins	do...	1
Provisions	do...	122
Grain	do...	25
Miscellaneous	do...	40
Total	do...	578
Estimated value		$53, 600

Jefferson, Tex., received 7,000 bales cotton and shipped 6,925 bales during the year. Only 355 bales were reported shipped by the water route.

Freight rates are reported to be as follows:

Sugar, by rail, New Orleans to Jefferson, 50 cents per 100 pounds; to Shreveport, 10 cents; merchandise, by rail, New York to Jefferson, $1.75 per 100 pounds; to Shreveport, 74 cents; Jefferson to New York, all water route, 60 cents per 100 pounds.

The distance by rail from Shreveport to Jefferson is 56 miles; by water, 65.8 miles.

CORRESPONDENCE WITH JEFFERSON COMMERCIAL CLUB RELATIVE TO IMPROVEMENT OF CYPRESS BAYOU, TEXAS.

I append certain correspondence between the Jefferson Commercial Club and this office relative to improvement of Cypress Bayou, and copy of a complaint by that body to the Secretary of War.

With reference to the latter, a comparison is respectfully invited between the statements made therein and the facts as given in the reports of myself and predecessors, especially to report of February 20, 1890, called for by resolution of the House of Representatives of February 6, 1890 (Report Chief of Engineers, 1890, p. 1914), and to the report on survey of Cypress Bayou (Report Chief of Engineers, 1893, p. 2065).

JEFFERSON COMMERCIAL CLUB,
Jefferson, Tex., May 15, 1896.

SIR: This city and adjoining country are very much interested in the question of navigation between here and New Orleans. The Commercial Club believes that if you will do us the honor to visit our city in person and investigate the situation, and not depend on others for information, that you will doubtless change your opinion, at least as to the necessity of the improvement. We believe that we can show you wherein a greater scope of country will be benefited than you imagine; that it is not entirely local in the benefits to be derived from the improvement.

We trust you will give the matter your personal investigation, and we are satisfied you will reach an entire different conclusion from the one you now entertain.

Such information as the club can furnish you will be gladly given. Very great injustice has been done us by stopping the flow of water into the lakes. At least this damage should be repaired, if no more. Justice demands that our water facilities should be equal to Shreveport.

Yours, very truly,
W. T. ATKINS,
President Jefferson Commercial Club.

Maj. J. H. WILLARD.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., May 19, 1896.

SIR: You letter of 15th instant, respecting improvement of Cypress Bayou and the lakes between Jefferson and Shreveport, has been received.

The river and harbor act of September 19, 1890, directed the Secretary of War to cause a survey to be made of Cypress Bayou and the lakes to determine if navigation could be materially and permanently improved by locks and dams, and, if found practicable, the probable cost thereof to be reported. The survey was assigned to me and was completed in 1893. You probably have seen my report thereon, printed in Report Chief of Engineers for 1893, pages 2065–2082.

I have been over the water route from Shreveport to Jefferson, have visited your city several times in making the trips, and was not dependent on others for my information. The survey was thorough, and gives a solid foundation of fact for future development. The commercial statistics showed the business done, so far as could be learned by persistent inquiry. Blanks for the purpose were sent out each year, and an assistant was sent to Shreveport, Jefferson, New Orleans, etc., to collect and compile the data. It is a notable fact, however, that those interested or engaged in navigation, as a rule, will not take the trouble to furnish information on the subject if they can avoid it.

The laws do not call for my opinion as to the propriety or expediency of making appropriations, but they do require facts, both as to cost of works and as to the commerce interested, in order that Congress may determine the question whether the general commerce of the country will be promoted by a work of improvement.

Referring to your offer to furnish information, I send herewith six forms of circular now being sent out to collect commercial statistics to accompany my reports for the current fiscal year, which please distribute to those interested or engaged in navigation of the bayou and lakes, and send me a list of the names and addresses of the persons to whom furnished. If more forms are needed they will be furnished on application. Your club, as a body of prominent men, doubtless can do much for the collection of accurate data.

If the pending river and harbor bill becomes a law, there will be available $15,000 "for dredging and removing obstructions and straightening channel between Jefferson, Tex., and Shreveport, La.," and an elevator dredge, well adapted for the purpose, recently purchased for general service on the streams of this district, will be sent to do the work as soon as it can be spared.

Very respectfully,

J. H. WILLARD,
Major, Corps of Engineers.

W. T. ATKINS,
President Jefferson Commercial Club, Jefferson, Tex.

JEFFERSON COMMERCIAL CLUB,
Jefferson, Tex., August 1, 1896.

DEAR SIR: At a meeting of the Commercial Club yesterday afternoon a resolution was passed to the effect that the president of the club correspond with you relative to the expenditure of the $15,000 on hand and appropriated by the last Congress. The bayou is very low now. The logs and stumps that create sand bars can now be seen and easily removed. A survey of the bayou could now be more correctly made, owing to the low stage of the water, than at any other time. The dredge boat could do very effective work now, such as removing sunken logs, stumps, etc.

The city is now negotiating with the Vicksburg, Shreveport and Pacific Railway Company, looking to the extension of that road from Waskom Station or the State line, the western terminus of the Vicksburg, Shreveport and Pacific, to this point. The benefits to be derived by the company making the extension is so manifest that very little apprehension is felt on the part of the city in the extension not being made. The demands of the company on the city have been complied with. It is not on the volume of business that the city is now doing that we base our demands for navigation, but it is on what was done when we had it, and what we will do when the Government restores to us that which it has taken away. All the country, taking the Texas and Pacific as the southern line, west to Fort Worth, thence north to Red River, including about thirty counties, will be the beneficiaries by making the bayou here navigable. It is not doing the country named justice to have them deprived of the benefits of water rates, simply because the commerce of Jefferson does not apparently justify the expenditure by the Government of putting in a system of locks and dams. Marshall is now seriously contemplating the building of a railway from that city here, to connect with the Vicksburg, Shreveport and Pacific, and take advantage of our water. This would cost Marshall some $80,000, yet they estimate it would pay them to build the line, as the savings in freights would more than refund it in less than two years. From the foregoing you can form some idea of the benefits to be derived by the improvement of the navigation we have been praying for. We trust you will take the matter up at once, so that it can be properly presented to Congress in December next. Kindly advise us of your conclusions in the matter.

Yours, very truly,

W. T. ATKINS,
President Commercial Club.

Maj. J. H. WILLARD.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., August 4, 1896.

DEAR SIR: Your letter of the 1st instant, respecting work for improvement of Cypress Bayou and the lakes between Jefferson and Shreveport, has been received. In accordance with directions received June 22, on June 24, 1896, I submitted to the Chief of Engineers, United States Army, through the division engineer, Southwest Division, a project for expenditure of the funds appropriated for this work, but as yet have received no notification of action upon the paper.

Very respectfully,

J. H. WILLARD,
Major, Corps of Engineers.

W. T. ATKINS,
President Jefferson Commercial Club, Jefferson, Tex.

THE JEFFERSON COMMERCIAL CLUB,
Jefferson, Tex., June 14, 1897.

DEAR SIR: The estimate herewith submitted of the volume of business that would be directly benefited by the immediate and permanent improvement of both Cypress and Red rivers, so as to make navigation continuous throughout the year, is predicted on the estimated volume of business in some thirty counties. We assume the proposition that the proper and correct estimate of the business benefited by the improvement of the rivers heretofore referred to would be to take the extreme southwestern corner of Andrews County, adjoining New Mexico, thence east to the southeastern corner of Panola County, adjoining the Louisiana line, taking all of the territory north of that line in the State of Texas, and possibly a portion of the Indian Territory adjoining Texas, would and could be said to be largely benefited by the improvement asked. In the estimate made no account is taken of the wheat crop of northern and western Texas. A possible crop is now in sight of some 18,000,000 bushels. As New Orleans is rapidly forging to the front as an export market, especially for wheat and corn, is it not fair and just to assume that with the opening of Cypress and Red rivers, so that large and commodious boats could navigate these streams, as in years past, that much of the wheat and corn of north and northwest Texas would find its way to the markets of the world via the river route, thus cheapening the rates to the seaboard on the volume going out by the boats and also that going by rail? This, we presume, you will not deny as a matter of fact. Our estimate for the thirty counties is as follows:

Estimated population	600,000
Annual cotton crop (estimated) bales	600,000
Estimated value	$18,000,000
Freight to eastern seaboard (estimated)	$2,500,000
Savings in freight by water route	$1,250,000
Estimated cotton seed tons	300,000
Estimated value	$1,800,000
Estimated savings on freights	$300,000
Annual expenditure by the completion and development of the iron interests	$2,500,000
Estimated freights paid by all lines of business in thirty counties	$8,000,000
Estimated volume of business transacted in the thirty counties included in estimate	$80,000,000
Property idle, unoccupied, including furnace, gas works, woolen mill, brick buildings, and other investments abandoned in and near Jefferson, and depreciations in values for want of navigation in these streams	$3,000,000

The foregoing is, we believe, a very conservative estimate and shows plainly the great and grievous wrong that has been done this section of the State for the want of the navigation in question.

We urgently and earnestly recommend and petition that you, as the representative of the Government, make such recommendations for an appropriation sufficient in amount as will give and restore to this section of the State the navigation it once had. We are aware of the fact that other streams of less importance, in your own immediate department and in other sections of the United States, have received and are receiving large appropriations, and the beneficiaries herein are as much entitled to the appropriation asked for as any other section.

They are paying their proportion of the taxes necessary for the maintenance of the Government, and are therefore as much entitled to recognition and protection as any other portion of the Union.

We are not making an unreasonable demand. We are only asking for that which justly, honestly, and truly belongs to us.

Very respectfully,

THE JEFFERSON COMMERCIAL CLUB,
Per W. T. ATKINS, *Vice-President.*
GEO. NIEDERMEIER, *Secretary.*

Maj. J. H. WILLARD,
Corps of Engineers, U. S. A.

JEFFERSON COMMERCIAL CLUB,
Jefferson, Tex., August 31, 1896.

SIR: When the rights of the people have been ignored, and when the appeals of the people have been time and again unheard and put aside by subordinate officers, these officers assuming that the people whose rights have been ignored are unacquainted with the facts and surroundings and know nothing of the cause of their complaint, it becomes necessary that the people should appeal to higher authority, hoping that all wrongs heretofore done them may be righted, and the great financial losses sustained by reason of such negligence may, in a measure, be returned by the prompt righting of the wrong.

Feeling that this city, county, and the country—the beneficiaries by the improvements of Cypress River, including some thirty-odd counties, containing at least 500,000 people—have been and are being greatly wronged by the continued neglect of Cypress River and Red River below Shreveport, believing this, the Commercial Club of this city have determined to appeal to you, believing that you will not submit to any injustice being done anyone or any section of the country if the facts are honestly placed before you. This club disclaims all intention of impugning the motives of anyone, or doing anyone an injustice, yet such a grievous wrong has been done this section of the State by the neglect of the engineer in charge of this department that the club is forced to appeal to you for a proper investigation as to the cause of this continued neglect and injury done the navigation of Cypress River.

Senator Flanagan, of Texas, March 3, 1875, made the following statement: "I propose to amend, on page 15, by inserting at the end of line 340, 'for a continuation of the improvements of Cypress Bayou, in Texas, $50,000,' be continued," saying: "That is legitimate, and really the recommendation of the officers of the Government was some $312,000, but I had no idea that the Senate would be so liberally disposed, or I should have contended for $300,000; but I thought if I could get the $50,000 I would be gratified, and still shall be if the Senate will pass it."

It would seem that had the gentleman understood the situation he could have gotten what was recommended by the Government officers, $312,000. Evidently they were justified by the commerce in then making the recommendation.

January 5, 1885, Capt. Eric Bergland made the following report: "In compliance with letter to Maj. A. M. Miller, Corps of Engineers, dated Office of the Chief of Engineers, United States Army, Washington, D. C., July 31, 1884, and the requirements of the river and harbor act of July 5, 1884, I have the honor to submit the following report on the examination of Cypress Bayou and the lakes between Jefferson, Tex., and Shreveport, La., made for the purpose of ascertaining if the necessary improvements can not be made upon some other plan than building a dam across the Albany Flats, as recommended by the engineer."

It would seem that the engineer had recommended a dam across Albany Flats, yet for some cause and at the instigation of someone a plan was called for to see if some other plan could be found than the one suggested. Why was this done? Again, Captain Bergland says, under same date: "A report upon the examination of Cypress Bayou was sent to the Department by Major Miller, with letter dated August 1, 1883. In this report the amount estimated for the necessary improvements was given at $19,000. In order to ascertain whether any important changes had occurred since the examination in 1883, I directed Assistant Engineer F. S. Burrows to make an examination and submit plans and estimate for improvement. His report, which is submitted herewith, describes in detail the existing obstructions to navigation, the estimated cost of removing these, and the benefits to commerce that may be expected from such improvements." Your special attention is directed to this report. Captain Bergland, continuing, says: "It is estimated that an expenditure of $16,000 will secure safe navigation between Jefferson, Tex., and Shreveport, La., for a period of seven or eight months each year." Yet a previous recommendation had been made for a dam at Albany Flats. He further says: "As $94,000 has heretofore been appropriated for this improvement, I would recommend that the amount required to complete it be appropriated." He further says: "No work has been done on Cypress Bayou since 1880, with the exception of the removal of a number of leaning trees in February, 1884."

Mr. Burrows in his report of December, 1884, says: "Throughout Twelve Mile Bayou, which has a length of 11 or 12 miles, there is never less than 4 feet of water at the lowest stage. It has a width varying from 200 to 400 feet." Continuing, he says: "From the head of Twelve Mile Bayou to Albany Flats the channel through Sodo Lake contains all the water during a low stage, and is merely a continuation of Twelve Mile Bayou, being 200 feet wide, from 4 to 6 feet deep, having a strong current."

"In order to reclaim and improve navigation through the lakes, Major Howell submitted in 1874 a plan for the construction of a high-water dam, and a cut from Albany Point, on Sodo Lake, to Gold Point, on Red River, making the outlet from the lakes into Red River instead of through Twelve Mile Bayou, as at present. As the surface of the water at Gold Point in Red River is 6 feet higher than the surface of the water in Sodo Lake at Albany Point, the object was to gain the advantage of this extra elevation across the shoal water of Sodo Lake. This plan would undoubtedly solve the problem of navigation through the lakes, but its great cost (estimated at $372,580) has proved thus far an insurmountable obstacle to its adoption."

We will now quote from the report on the internal commerce of the United States for the year 1891. Speaking of the Erie Canal, Mr. J. C. Brown, statistician of the

New York Produce Exchange, says: "The Erie Canal cost $51,000,000, and the State expends on it $720,000 a year in keeping it in repair, but it effects a saving of over $4,000,000 a year in freight charges on the wheat alone that goes into New York City, to say nothing of five times greater weight of other freights going into and out of that city. The money is certainly well spent." He says: "The $4,000,000 saving was not on the wheat that went into New York through the canal, but all that went into the city by railroads also."

Thus you see it is not only the saving the country makes on the products that pass through the waterway, but on the railroads touching the water points. We submit the proposition that had Major Howell's plan, submitted in 1874, to give this section of the State (at a cost of $372,580) navigation been accepted and the work completed, the saving to the people alone on cotton would have fully reached $500,000 since then. In this estimate no calculation is made of other merchandise. The freight receipts at this place by the railroads average nearly $200,000 per annum, or nearly $5,000,000 since 1874, twenty-two years ago. A conservative estimate of 35 per cent on all other merchandise would have been saved had we had navigation. This is assuming that no increase of business would have taken place; yet everyone knows that the business would have at least doubled.

Mr. Brown further says: "It is not necessary that the water line should carry the freight to cheapen the rate. It cheapens what it does not carry as well as what it does. In short, it regulates rates on all lines of carriage that converge at a common point with it."

Your attention is respectfully called to the fact that the engineers, acting under instructions from someone, have, it appears to us, systematically destroyed the navigation of Cypress River for first one pretext and then another. The water of Upper Red River has been shut off so that no water from it can enter the lakes as nature provided that it should. The first and most disastrous step taken by your Department was the removal of the raft which was nature's dam to protect the navigation of Cypress River, and, we dare say, protect Upper Red River also. In engineering, as in chemistry, nature is the most skillful.

We desire to call your attention to the fact that in the estimates made for the improvements of Cypress River that no stress should be placed on the volume of business done by the river now, for the reason that navigation has for some cause been destroyed. You should estimate the volume of business done previous to the destruction of it and what would be done after its restoration. Justice is one of the cardinal virtues; so is restitution. This section of the State has been wronged, and at a cost of millions. We appeal to you to have restored to us that which has been taken from us. The flimsy excuse that large bodies of land have been redeemed by the stopping up of Red River is absurdity itself. There is too much vacant and unoccupied land in the United States to squander millions of dollars in excessive freights for such a purpose. We submit that if the Mississippi River was dammed at the mouth of Red River, and the waters of that stream forced through Atchafalaya into the Gulf, the city of New Orleans would soon become a victim to the greed of the railroads, and would not long exist. Your department has shut out our supply of water and not offered to give us any relief in place of it. Your engineer answers to our appeal for help and restitution, "Your commerce does not justify the expenditure." Congress has been importuned by numerous petitions from all over northern Texas, asking that navigation be restored in Cypress River. If the Government will restore to us the navigation we had, we will furnish the commerce.

In this section of the State there is a very large and undeveloped iron industry. This industry, you understand, requires large quantities of coal, and it must of necessity be cheap. Alabama is now putting her coal on the Mississippi River at Greenville. With ample navigation in both Cypress and Red River this coal could be barged here at a nominal cost. Can this interest be developed before you give us the water? Again, the products of the iron plant can be put in the markets by water. Can we do it unless you restore us the navigation we had? Navigation would save to the people of northern and central Texas thousands of dollars in freight alone on coal. We notice that streams of less importance than Cypress Bayou and Red River receive large appropriations, while ours gets a $10,000 appropriation, with $5,000 unexpended, for a resurvey, and, perhaps, adverse report, because the commerce does not justify it. For this reason, as before stated, we have been robbed of our water privileges.

No better time than now could be selected to remove the stumps, logs, and snags that would otherwise obstruct the navigation.

The club has called Major Willard's attention to it, but as yet nothing has been done. We submit that these small appropriations, making surveys, will not increase our prospects of getting the improvements so much desired. Navigation in Cypress River is practicable and feasible, so says Major Howell, and we think Major Benyaurd also. Then why not have an appropriation sufficiently large to do what is necessary to complete the work? It will certainly be admitted by everyone with any legal knowledge that even the Government has not the right to destroy the people's highway to the markets of the world. Restitution must be made when called on. This is, we understand, the common law. The club trusts that the Department will see the justice of our cause, and see that the great wrong that has been done this section of the State is at once, or as soon as practicable, righted.

We have endeavored to place the matter before you in an impartial way, and without any prejudice to anyone. We have stated the facts as we understand them. We have made this more voluminous than we intended, yet we can only plead in apology the justice of our cause and the earnestness of the 500,000 people that demand that the restitution they deserve be made and the grievous wrong done them be righted.

Kindly make a thorough investigation of the matter and favor us with your conclusions.

We are, very respectfully,

THE JEFFERSON COMMERCIAL CLUB,
By W. T. ATKINS, *President.*

HON. SECRETARY OF WAR.

U 4.

IMPROVEMENT OF OUACHITA AND BLACK RIVERS, ARKANSAS AND LOUISIANA.

Operations in these streams during the fiscal year ending June 30, 1897, were continued as follows:

GENERAL IMPROVEMENT.

The U. S. snag boat *O. G. Wagner*, Watkins Decker, master, commenced work at mouth of Black River November 1, 1896, and from that date to January 5, 1897, continued upstream to Monroe, La., a distance of 174 miles. All obstructions in the channel that could be located were removed, and the stages were favorable for this class of work until November 27, when a temporary rise set in.

During the period of lowest water, November 1–26, operations were carried up to Bayou Louis Bar, and the master of the snag boat reported notable improvement at the following places, viz, Little Prairie Bend, below Hardscramble Landing, between Oakland and Monterey, and at Kincaid Bayou, in Black River, and just above Big Orchard, Tew Place, above and in front of Hope Landing, Harrisonburg Bar, and lower end of Bayou Louis Bar, in Ouachita River.

On reaching Catahoula Shoals, November 30, a break in the dam at that place was found, and the day was spent in trying to check it with the means at hand. The breach was about 50 feet wide, and the caving and widening was stopped at both ends by means of sacks of earth, which was all that could be done, with the water rising rapidly.

The rise of Lower Ouachita continued until December 6, when it reached about an 18-foot stage. A fall set in at once, and by end of December the stage was about 3 feet above low water. December 1–13 the *Wagner* continued work from Catahoula Shoals to Lafeta Landing. The water having fallen considerably in this period, December 14 and 15 the boat returned to Catahoula Shoals, where it was employed in repairing the break in the dam until December 23. The break occurred where the former channel was, and when the *Wagner* commenced repairs, December 15, there was about 2 feet depth over the dam. The current had slackened considerably, and there seemed to have been no caving since the attempt to check it November 30. The trunks of 17 heavy trees, ranging from 24 to 60 feet in length and 2 to 3 feet in diameter at butt, were laid across just below the breach to stop the current, after which the hole in the dam was closed with sacks of earth, weighted down with a layer of rock about 1 foot thick. This fill was a necessary expedient, and was not intended and can not be expected to hold permanently. As soon as practicable this part of the dam should be rebuilt and its section increased.

December 23–January 5 the *Wagner* worked from Catahoula Shoals to Monroe. The channel was cleared of all obstructions in sight, and the drag chain used at shoal places to catch those hidden from view. Timber was cut from caving banks in short bends below Pritchard Landing, opposite Needle Point and below George Bridger's, to prevent its sliding into the channel.

Until the latter part of the year the river stages were too high to resume snagging operations, and the *Wagner* was laid up at Monroe, where needed repairs of the vessel were made.

The following is a summary of the work done by the *Wagner* November 1–January 5, viz:

Snags pulled	573
Stumps pulled	45
Stumps cut and destroyed	16
Shore snags cut and destroyed	294
Side jams removed	2
Leaning trees cut	419
Trees girdled	52

Repaired break in dam at Catahoula Shoals, requiring the placing of 17 tree trunks, 3,200 sacks of earth, and about 180 cubic yards of rock.

When work in Bayou Bartholomew was suspended, October 17, 1896, the party, equipped with axes, saws, tackle, explosives, etc., under local supervision of Overseer J. R. Vaughan, was transferred to Ouachita River. October 19–November 26 operations were carried upstream from mouth of Bartholomew, La., to Lapile Landing, Arkansas, a distance of 36 miles. Work consisted of cutting or destroying leaning trees, logs, and stumps along the banks, and removing channel and shore snags. Whenever practicable, they were cut or sawed up, but where this was difficult they were removed with block and tackle or destroyed with explosives. The worst obstructions found were caused by tree slides, which were felled, cut into short lengths, and the stumps removed. The stage was low, and effective work was done; points and bends were all cleared; trees and logs that had lodged upon bars were removed; deadened timber along the shore was felled and cut up, or pulled far back in the woods; and every effort was made to put the stretch in safe and navigable condition. Numerous obstructions were found along what are known as the "Thirteen Points," above Alabama Landing, and the banks were caving badly along the entire stretch worked over, whole trees having slid or fallen into the river. The shallowest places were at Papaw Shoals, a sand bar, the depth on which scoured at once from 8 inches to 2½ feet after logs were removed from the channel; Romeo Shoals, a gravel bar, where little increase of depth was obtained; Hightower Shoals, where the river is wide, and after removing a few logs in the channel the quarter boat passed up without difficulty, but no increase of depth was observed; just below Alabama Landing a bed of logs was removed, increasing the depth from 8 inches to 2 feet; Upper Shiloh Shoals, a sand and gravel bar, covered with logs and fallen trees brought in by caving banks, the removal of which afforded 2½ feet depth at the low stage; and at McDonald Crossing, just above the latter shoal, a sand bar, from which snags and logs were removed, increasing the channel depth from 8 inches to 2 feet.

Heavy rains set in the latter part of November, and by the 28th the water had risen so much that work could not continue to advantage.

The quarter boat was dropped down to Ouachita City, where the force was laid off November 30. By December 22 the stage was low enough to resume operations, the party was reemployed, and from then to January 4, 1897, continued work downstream to Lonewa, a distance of 10 miles. High water at this time stopped the work, the force was discharged, and the quarter boat was dropped down to Monroe and laid up with the fleet at that place January 5.

The following work was done by this party in the period October 19–January 4, viz:

Channel snags cut and destroyed	3,943
Stumps cut and destroyed	1,251
Shore snags cut and destroyed	713
Logs cut and destroyed	2,502
Leaning trees cut and destroyed	3,319
Trees girdled	610
Square yards willows and brush cut	6,697

In June, 1897, the U. S. snag boat *Columbia*, with Watkins Decker as master, made a patrol of Ouachita River and tributaries, to remove channel snags, floating butts, etc. At the moderately high stage only 26 snags were found between Monroe, La., and Camden, Ark., and none between Monroe and Trinity, La.

During the coming season it is proposed to employ a party at low stages to cut leaning timber, clear caving and sliding banks, and remove obstructions in the channel of the upper river between Camden and Lapile Landing, Arkansas. Below Monroe to Red River operations of the snag boat *Wagner* will be continued, and the dam at Catahoula Shoals repaired.

SURVEY.

During July and August, 1896, office work upon maps and notes was continued, and preparations were made to resume field work.

To expedite progress of field work during the favorable conditions of weather and low water, arrangements were made to float two small quarter boats used the preceding season from Monroe down to Sinope, La., and to send the U. S. steamer *Columbia*, with the main party, supplies, and outfit to Alexandria, La., on Red River, and, after completion of a survey at that place, the steamer was to proceed to Sinope, where organization would be completed and field work resumed. The party was to be quartered upon the *Columbia*, and the quarter boats taken along for use in case low water should necessitate laying up the steamer.

September 3–9 the quarter boats were moved from Monroe to Sinope, and the *Columbia* left Vicksburg September 7, but was unable to go up Red River on the extreme low stage, and turned back near the mouth of Saline Bayou, September 10. Assistant Engineer T. O. Thomas, a recorder, and a laborer proceeded overland to make the survey at Alexandria, and the *Columbia* returned to Ouachita River, but was unable to cross Bayou Louis Bar, just above Harrisonburg, on the low stage, and was laid up at Harrisonburg, September 16, to await a slight rise, or until the survey should reach that place. Teams were hired, and the instruments, outfit, and supplies hauled about 54 miles by road to the quarter boats at Sinope.

The survey was resumed at Sinope, September 21, and from that date to December 23 was carried down to mouth of Black River and tied on the survey of Red River. The programme of work was essentially the same as followed the preceding season (see Report Chief of Engineers, 1896, p. 1595); but as precise levels had been run previously from mouth of Black River to Monroe, they were not required, and on account of this exception the scope of topographical work was increased. The main banks of the river were traced continuously without regard to the distance they might lead back, but particular attention was given all breaks, whether by swales or bayous. Lakes partly within the limits of topography were traced complete by stadia or sketch, and the hill line was traced continuously (except where long distances back) by stadia when within the 800-meter (about one-half mile) limit, otherwise by sketch. A large amount of back topography was taken on the right bank below Bœuf River to Harrisonburg, necessitated by a system of flank waterways leading far beyond the usual limits, and which could not be sketched as elevations, were the important feature. Along Black River, below Trinity, La., as a rule main banks were not traced by stadia far beyond the one half mile limit; minor bayous stopped by levees were traced to that limit and dropped, and flanking waterways were not studied so closely as along the Ouachita. All topography, front and back, except contour points, was plotted on the field sheets, and an earnest effort made to reduce to a minimum omissions and discrepancies uninvestigated in the field. On the way down, Bœuf River was run out for a distance of about 8 kilometers (near 5 miles), and a permanent reference line established at the upper limit.

The steamer *Columbia* left the mouth of Black River, December 24, and on reaching Trinity the survey of Tensas River was taken up and continued to Stanton Station, on the Natchez, Red River and Texas Railroad, about the same distance as the survey of Bœuf River, where a permanent reference line was established and tied in by check levels and triplicate stadia lines. On reaching Catahoula Shoals an examination of the dam at that place was made. It was relocated in detail, cross-sectioned at intervals with level and tape, and the extent of the breach determined as closely as practicable, with the new fill placed by the U. S. snag boat *Wagner*. The fill was cross-sectioned also, and the sections extended some distance above and below the dam by soundings. Sounding sections used November 4, 1896, in neighborhood of the dam were relocated and re-sounded to ascertain the effect, if any, of the break. On completion of this work the *Columbia*, with the two quarter boats in tow, returned to Monroe, reaching that place January 2, 1897. On account of stormy weather and high stages of river, the boats were laid up and the field party discharged with the exception of the employees required to work up notes of survey at the office.

Office work continued until the latter part of May, 1897. March 28–April 27, 1897, high-water discharge measurements were made at Monroe, La.

To close the gap in the survey above Champagnolle to Camden, Ark., and to provide shelter for the field party before the river reached a stage too low to tow, the U. S. steamer *Columbia* left Monroe, with a quarter boat for the purpose, April 28, reached Camden May 2, and returned to Monroe May 7. High-water gauges were set at intervals on the way up.

Several days were spent at and near Camden completing preparations for field work. The organization was perfected May 10, work down the river commenced that date, and the chain-line cutting passed Frenchport May 13. At Frenchport precise leveling was resumed, starting from the bench marks established at that locality in 1894, were carried to the precise bench mark at Eldorado Landing, and discontinued at the latter place May 28. May 31 test levels were run from Eldorado Landing to Champagnolle. The chain-line cutting closed on the permanent reference line, established in 1895 a short distance below Champagnolle, on May 29. The precise levels followed the chain-line cut and the main line crossed the river twice. The river crossings were made by reciprocal levelings, but, as only one instrument was available, simultaneous cross-river readings could not be taken. For this reason it was thought best to get results under some diversity of conditions, and each crossing was duplicated the day following the original observation.

June 1 test levels were run between the precise benches established in 1895 at and near Champagnolle, and the next day the party returned to Camden. At Camden the force was increased by such additions as were necessary, and during the month the chain line, topography, hydrography, and ordinary levels between that place and Champagnolle were completed. With exception of excessive heat the latter part of the month the weather conditions were favorable. A sharp rise occurred early in the month, but subsided quickly, so that the greater part of the survey was made at a low stage. More than the usual amount of sketching was done in tracing out back bends, bayous, and lakes, and those of importance were traced by stadia. A number of flank waterways, lying far back from the river, could not be traced within reasonable time or cost on account of thick underbrush and canebrakes, but all available information concerning them was obtained from inhabitants of the localities, the essential point being the stages at which the river discharges through side channels, generally found to be about 6 meters (near 20 feet) or more above low water, which would not interfere with canalization by dams of moderate height.

In the early part of June an assistant and recorder were employed in checking short stretches in the precise levels near Donaldson, on the line of 1894 from Little Rock to Camden, and on the line of 1897 below Camden. On completion of this work preparations were made for precise leveling from Greenville, Miss., and Arkansas City, Ark., along the line of railroad to Bonita, La., near Bayou Bartholomew, and down that stream to its mouth.

The chief draftsman was sent out with the topographical party and plotted their work on tracing linen, thus permitting errors that might occur to be corrected while close at hand, and giving a good outline map for immediate use and for laying out the final sheets to best advantage. The main river has been mapped in this way from the St. Louis Southwestern Railway Bridge above Camden, Ark., to Red River, on scale 1:10,000, a distance of about 575 kilometers (360 miles). With careful adjustment this will require not less than 50 sheets atlas (60 by 80 centimeters within borders) for the finished maps, and about 72 sheets for the profiles.

The possible sites for dams will be elaborated on scale 1:1,000 with profiles and sections probably 10 to 1. The meridian is parallel to one border on each sheet, and this number of sheets will be necessary both on account of the great number of bends and windings of the stream, not infrequently reversed, and the general southeasterly course from Camden to Red River, the southing amounting to 260 kilometers (162 miles) and the easting to 93 kilometers (60 miles).

The field sheets are now being inked as rapidly as possible, to furnish blue prints for a progress report if one should be called for.

The precise levels have been completed between Arkadelphia and Red River, and office computations of the stretch between Frenchport and Champagnolle will be taken up and finished early in July.

Six authentic benches of the survey of 1873 have been found, and two of 1871, and as the levels of 1873 touched twenty-six of the previous survey, some use may be made of their work in the immediate neighborhood of these benches. The extreme variations in the levels of 1873, as tested by the precise levels, is 1.2 meters (nearly 4 feet), ranging from 2.3 feet low at bench 17 of 1873, at Pigeon Hill, to 1.6 feet high at bench 14 of 1871, a few miles above Trinity. Unfortunately, I have no means of locating the errors, as the original notes can not be found, the books in this office being copies. The notes of 1871 are originals, and the tests by precise levels indicate less variation than in those of 1873. But, singularly enough, the apparent discrepancies between the levels of 1871 and 1873 from bench 14 of 1871 to Camden are such that the difference of elevation by the precise levels is almost exactly a mean between them. There are no gauge records for 1871, although it is known that there was at least one gauge at Camden, Ark., but there are broken records of gauges in 1873 at Camden, Buffalo Flats, Eldorado, Monroe, Columbia, and Trinity. No records of established benches or testing can be found, however, so that their value is doubtful.

There have been no great floods in Ouachita River since the present survey began, so that discharge at high stages will remain a matter for estimate.

From the great range at Monroe between low water of 1881 and high water of 1882, over 15.25 meters (say 50 feet), 4,000 cubic meters per second (say 140,000 cubic feet) should not be considered an extravagant estimate. But the only way to settle the question is to watch the weather reports and send out gauging parties on the approach of a flood.

Conditions have been favorable for observations at low stages, and discharge has been measured at many points, especially above and below the mouths of tributaries. This work will be given in detail and in tabulated form when finished, but a few approximations are given below, actual stage not stated:

Eutaw Rapids	10.0 C. M. S.	(350 C. F. S.)
Alabama Landing	12.0 C. M. S.	(420 C. F. S.)
Columbia	14.3 C. M. S.	(500 C. F. S.)
Columbia, stage 4.6 (15 feet) higher	325.0 C. M. S.	(11,375 C. F. S.)
Bœuf River	7.0 C. M. S.	(245 C. F. S.)
Catahoula Shoals	32.4 C. M. S.	(1,134 C. F. S.)

These results are not encouraging, and indicate a much smaller discharge at extreme low water than had been supposed.

Should it be decided that a slackwater system is feasible and worthy to be undertaken by the United States, this fact will have great weight in determining not only the type of dam, its lift, etc., but the size of the locks, which I fear would have to be much smaller than hoped for by those who have interested themselves in the project. The great range between extreme stages in Ouachita and its tributaries would require either a great number of dams of small lift, or a type of movable dam allowing the least leakage, and it is not at all unlikely that a mixed system might be decided upon.

Fortunately the revival of interest in the subject of American gates has led to the approval of improved forms of bear trap, drum wickets, and needle dams, which will be tested on large scales within a year, the results of which will doubtless be of substantial aid in the study of the project for Ouachita River and its tributaries.

Former surveys of Ouachita River contemplated slackwater in the main stream without regard to the tributaries, but this survey contemplates forming a system, the idea being to place the dams below the mouths of Tensas and Maçon, Bœuf, D'Arbonne, Bayou Bartholomew, and Saline River, so that they shall be pooled at the same time as Ouachita River, according to their slopes. All available maps of these streams have been collected, some made lately by reconnaissance with Land Office maps in hand, and while it is not proposed to make an elaborate survey of each, it is intended to make a sufficiently accurate survey of each from its mouth upstream, say for 50 kilometers (about 30 miles), or to the limit of the probable pool.

It will be necessary also to run out all side channels or lakes along Ouachita River, and to extend the sections across the valley, especially in that portion long known as the "Overflow," not only to insure against diversion or flanking, but to protect the United States from suits for damages from overflow which might otherwise be charged to dams.

For like reasons special pains have been taken to get accurate levels of authentic high-water marks throughout the whole valley. Therefore, while it is hoped to complete the survey for considerably less than first estimated, I think it unsafe to reduce it at the present time.

Work will be resumed in the field as soon as it is considered prudent to do so, and in the mean time the notes will be computed and put in shape and the field maps urged to completion.

ESTIMATES.

Completing survey	$70,000
Quarter boats for chopping parties	5,000
Outfit, tools, and repairs	2,500
Expenses of snag boats	25,000
Expenses of chopping parties	10,000
Expenses of dredges	5,000
Administration, transportation, gauges, etc	2,500
Total	120,000

Money statement.

July 1, 1896, balance unexpended	$76,354.73
June 30, 1897, amount expended during fiscal year	29,541.78
July 1, 1897, balance unexpended	46,812.95
July 1, 1897, outstanding liabilities	57.64
July 1, 1897, balance available	46,755.31
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	120,000.00

The amounts expended during the year and balances July 1, 1897, are as follows:

Allotments.	Expended during year.	Balances July 1, 1897.
For general improvement, repairs, care of plant, etc	$8,851.07	$11,159.31
For survey	20,690.71	35,653.64
Total	29,541.78	46,812.95

The appropriations have been as follows:

Date of act.	Locality.	Amount.
Mar. 3, 1871	Between Arkadelphia, Ark., and Louisiana State line	$25,000
Do	Between Arkansas State line and Trinity, La	26,000
June 10, 1872	Between Arkadelphia, Ark., and Louisiana State line	60,000
Do	Between Arkansas State line and Trinity, La	40,000
Mar. 3, 1873	do	60,000
Aug. 14, 1876	Between Camden, Ark., and Trinity, La	12,000
June 18, 1878	do	10,000
Mar. 3, 1879	do	10,000
June 14, 1880	do	8,000
Mar. 3, 1881	do	12,000
Aug. 2, 1882	do	12,000
July 5, 1884	Between Camden, Ark., and mouth of Black River, Louisiana	15,000
Aug. 5, 1886	do	17,500
Aug. 11, 1888	do	20,000
Sept. 19, 1890	do	15,000
July 13, 1892	do	40,000
Aug. 18, 1894	Between Camden, Ark., and mouth of Black River, Louisiana, including survey	50,000
June 3, 1896	Between Camden, Ark., and mouth of Black River, Louisiana, and for completion of survey	70,000
	Total	502,500

COMMERCIAL STATISTICS.

During the fiscal year 1897 Black and Ouachita rivers were navigable for regular New Orleans packets to Camden, Ark., from November 28 to June 10. Smaller boats made irregular trips above Monroe, La., at intervals prior to November 28. Below Monroe to Harrisonburg navigation was suspended about four months, during the period of lowest water. There was navigation to Harrisonburg, La., the entire year.

List of steamboats engaged in the trade during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.				Between—	Round trips.	Passengers.
						Light.		Loaded.				
			Feet.	Feet.	Feet.	Ft.	In.	Ft.	In.			
Ouachita	Stern-wheel.	457.45	189	38	6.5	4	0	10	0	New Orleans and— Monroe	18	1,958
										Danville	1	
										Harrisonburg	1	
City of Camden	do	299.23	175	35	5.5	2	2	5	6	New Orleans and Camden.	5	2,460
										Monroe and Camden	13	
										New Orleans and— Alabama Landing	4	
										Harrisonburg	13	
										Columbia	8	
Parlor City	do	136.3	125.	26	8.7	2	0	5	0	New Orleans and— Monroe	27	500
										Sinope	1	......
										Monroe and— Bayou D'Arbonne	1	......
										Saline River	1	......
										Boeuf River	1	......
T. K. Green *a*	do	32.77	81.8	17.3	3.1	1	8	3	2	Trinity and Little River.	....	250
										Trinity and Tensas River and Bayou Maçon.	95	100
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2	6	4	6	Monroe and mouth of Black River.	6	60
										Monroe and Bayou Bartholomew.	1	......
										Jonesville and Bayou Maçon.	7	......
Le Vere	Stern-wheel.	98.73	109.2	23.9	2.9	0	11	2	6	Monroe and Bayou D'Arbonne.	2	......
										Monroe and local landings above and below.	8	......
										Monroe and Bayou Bartholomew.	24	......

a With one or more barges.

List of steamboats engaged in the trade during the fiscal year—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
Lillie *a*	...do	61.42	120	26	3.5	2 0	4 0	Jonesville and New Orleans.	5	......
								Local towing out of Little River to mouth of Red River.	....	......
C. A. Hill *a*	...do	69.62	119.5	21.3	3.6	......	......	New Orleans and Camden.	1	......
								Local towing near Monroe.	....	......
City of Brunswick *a*	...do	77.01	87.9	19.6	3.9	2 0	3 0	New Orleans and Boeuf River.	1	......
Excel *a*	...do	118.9	122	21.5	3.5	......	......	New Orleans and— Saline River	1	......
								Camden	2	......
Belle Prince *b*	...do	109.12	114.4	19.6	3.6	1 0	7 6	New Orleans and— Saline River	14	......
								Camden	3	......
Stoneware *b*	...do	74.21	100	17	3	2 2	3 6	New Orleans and Boeuf River.	1	......
Rosa B.	...do	41.85	82.6	15.8	3	1 5	2 6	Monroe and Bayou D'Arbonne.	36	41
Belle of D'Arbonne	...do	74.59	111	22	3.7	2 0	4 0	Monroe and New Orleans.	....	......
								Camden and New Orleans.	1	......
Will Davis *a*	...do	75	100.8	23.6	3.6	1 8	2 2	New Orleans and Camden.	3	......
Victor *a*	...do	138.67	138	26	4.6	......	......	...do	3	......
J. W. Swayzie *b*	...do	......	......	......	......	......	......	Jonesville and Bayou Maçon.	25	......
								Jonesville and Little River.	24	......
E. H. Barmore *a*	...do	171.47	135.7	30.1	5.4	2 6	5 0	Jonesville and Baton Rouge.	1	......
								Jonesville and Tensas River and Bayou Maçon.	2	......
Ramos *a*	...do	18.81	60.2	11.5	6	......	......	Jonesville and Tensas River and Bayou Maçon.	4	......
H. M. Townsend *a*	...do	89.7	116.7	18	3.1	......	......	New Orleans and Camden.	1	......
G. W. Lyon *b*	...do	86.17	115	22	4.4	......	......	New Orleans and Upper Ouachita.	1	......
Grover K *b*	Tug	4	......	......	......	3 6	3 6	Knight Landing and Columbia.	19	......
								Knight Landing and Montgomery.	17	......
Lee Otis *b*	...do	4.5	......	......	......	4 6	4 6	Stafford Point and Red River.	1	......
								Stafford Point and Boeuf River, local towing.	....	......
Dora *b*	...do	3.5	33	9	5	2 11	4 0	Jonesville and Tooleys.	156	110
Julia H *b*	...do	4.9	35	7	......	4 0	4 0	Jones Landing and mouth Boeuf River.	24	......
								Stafford Point and Boeuf River.	5	......
Irwin *b*	...do	3	35	8	......	2 6	3 2	Stafford Point and Boeuf River, local towing.	....	......
May Fisher *a*	Stern-wheel.	52.84	92	18.8	4	......	......	Tensas River and Baton Rouge.	1	......
Wall's Gasoline *b*	...do	7	70	10	2	0 6	1 6	Monroe and Bayou D'Arbonne, local towing.	....	......
Robinson's Gasoline. *b*	...do	12	65	12	2.5	1 0	2 6	...do	....	......
Wayzata	Tug	6	33	7	3.7	1 9	2 2	Local towing to sawmills at Monroe.	....	......
Skipper	...do	......	......	......	......	......	......	...do	....	......
Dixie *b*	...do	16.94	52.6	12	4	4 0	4 6	New Orleans and Boeuf River.	1	......

a Towboat. *b* With one or more barges.

Summary of commerce reported.

Articles.	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	12,959	9,599	21,070	11,176	11,383	21,890	21,433	16,652
Cotton seed	22,657	4,706	6,005	3,645	4,423	5,577	6,593	5,058
Hides and skins	16	68	166	72	4	7	25	36
Live stock	561	254	329	549	845	89	172	62
Lumber	2,302	1,080	218	262	18,000	461	16,388	7,951
Saw logs	51,066	49,000	10,000	28,257	28,000	26,880	120,000	50,000
Staves	119,059	26,332	18,891	31,519	9,378	23,402	17,888	21,159
Rock	....	....	....	....	....	....	18,000	....
Miscellaneous	3,540	7,112	5,660	6,572	5,251	5,197	10,856	783
Total down freight	212,160	98,151	62,339	82,052	77,284	83,503	211,355	101,701
Return freight	17,390	19,866	11,340	13,808	11,157	18,317	27,842	40,766
Total	229,550	118.017	73,679	95,860	88,441	101,820	239,197	142,467
Estimated value	$5,722,000	$5.123,000	$3,293,000	$3,430,000	$4,466,000	$6,680,600	$9,130,000	$10,234,250

Of the above freights, the tributaries of Ouachita River contributed 82,479 tons, valued at $1,000,000.

The drought of 1896 was the longest and most disastrous of record. Morehouse Parish was the center, and it extended into the parishes of Ouachita, Caldwell, Catahoula, Grant, Winn, Natchitoches, Bienville, Webster, Claiborne, Lincoln, Jackson, and Union, the majority of which are tributary to Ouachita River. Charitable distribution was made to the smaller class of farmers in these parishes of 966,000 bushels of corn, and provisions which cost $362,596.

Receipts and shipments of bales of cotton at Monroe, La.

Route.	1896-97.		1895-96.		1894-95.	
	Received.	Shipped.	Received.	Shipped.	Received.	Shipped.
Vicksburg, Shreveport and Pacific R. R.	11,406	19,661	17,418	27,077	16,514	31,389
Missouri Pacific Rwy	21,421	28,381	14,731	19,975	22,383	32,271
River	1,579	3,133	3,770	6,207	4,698	5,204
Wagon	17,087	....	17,872	....	25,358	....
Total	51,493	51,175	53,791	53,819	68,953	68,864

The compress at Monroe cost $80,000, has a storage capacity of 12,000 bales, and a compressing capacity of 100 bales an hour.

Receipts and shipments of bales of cotton at Camden, Ark.

Route.	1896-97.	
	Received.	Shipped.
Missouri Pacific Railway	1,342	5,381
St. Louis Southwestern Railway	3,896	6,902
River	918	5,963
Wagon	13,822	....
Total	19,978	18,246

The following information was furnished by the Camden Commercial League as showing the resources of the country whose commerce and freight rates are affected by navigation of Ouachita River:

	1896–97.	1895–96.
Population of territory affected	608, 983	564, 518
Annual cotton crop (estimated) ... bales	878, 578	813, 498
Estimated value	$34, 150, 230	$32, 539, 920
Present freight rate per bale to eastern seaboard	$3. 60	$3. 50
Freight saving on cotton, if water route were available	$1, 640, 000	$1, 550, 000
Annual crop of cotton seed (estimated) ... tons	420, 000	385, 000
Estimated value	$4, 000, 000	$4, 000, 000
Freight saving on cotton seed, if water route were available	$1, 235, 000	$1, 145, 000
Lumber marketed ... tons	5, 228, 318	4, 835, 000
Value of lumber shipped	$91, 896, 380	$82, 700, 000
Taxable property in district	$87, 538, 000	$84, 635, 000
Amount of freight paid all lines of transportation	$18, 785, 000	$17, 815, 000
Amount of business transacted	$212, 958, 000	$197, 895, 000

The prevailing freight rates are as follows: By river from New Orleans to Camden, on flour, meats, rice, sugar, molasses, salt, nails, bagging, ties, etc., per 100 pounds, ranges from 10 cents for salt to 12½ cents for flour, and not to exceed 25 cents on other articles. By rail the rate is 70 cents per 100 pounds for all. A bale of cotton goods weighing 400 pounds costs $1.10 for transportation by river and $4.40 by rail. The freight on a carload of cheap furniture from Chattanooga, Tenn., to Camden, Ark., amounted to $133. From Chattanooga to Memphis, Tenn., 310 miles, the charge was $22, but from Memphis to Camden, 208 miles, it was $111. When there is navigation the rate per bale on cotton from Camden to New Orleans is $1 by rail or boat, but when navigation is suspended it is advanced to $3.10 by rail.

The competing lines of transportation are as follows: Ouachita River is crossed by the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark.; by the St. Louis Southwestern Railway (Cotton Belt Route) at Camden, Ark., and by the Vicksburg, Shreveport and Pacific Railroad at Monroe, La. The St. Louis, Iron Mountain and Southern Railway has a branch line parallel to the river from Eldorado to Gurdon, Ark., and thence by the main line to Arkadelphia. A projected extension of this branch will give direct communication with the Mississippi River at Arkansas City, Ark., the part to be built being from Camden to Warren, Ark., a distance of about 50 miles. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) connects with Arkansas City at McGehee, 12 miles west, and thence runs in a southwesterly direction about midway between Bayou Bartholomew and Bœuf River, touches the Ouachita River, and crosses the Vicksburg, Shreveport and Pacific Railroad at Monroe, La., and continues down, parallel to the main river, to Columbia, La., crossing at Riverton, 4 miles above Columbia, and runs thence to Alexandria, La. The Natchez, Red River and Texas Railroad (narrow gauge) runs from Black River Station, opposite Trinity, to Vidalia, La., on Mississippi River opposite Natchez, Miss. The New Orleans and Northwestern Railway is completed from Natchez, Miss., to Bastrop, La., and crosses Tensas River near its mouth and Bœuf River about 2 miles north of Rayville, La. A railroad from Sunnyside, Chicot County, Ark., on Mississippi River, to Hamburg, Ark., crossing Bayou Bartholomew near Portland, is projected. The extension of the Kansas City, Watkins and Gulf Railway from Alexandria, La., to Natchez, Miss., has been begun, and will cross Black River about 7 miles below Trinity, La.

U 5.

IMPROVEMENT OF BAYOU BARTHOLOMEW, LOUISIANA AND ARKANSAS.

May 21, 1896, a party equipped with axes, saws, explosives, etc., was organized under Overseer James R. Vaughan, and between that date and June 30, 1896, carried operations from McComb Landing, near mouth of Bearhouse Creek, the present head of navigation, downstream to within 2 miles of Parkdale, Ark., a distance estimated to be about 46 miles.

During the fiscal year ending June 30, 1897, operations of this party were continued as follows:

From July 1 to October 17, 1896, work was carried downstream to mouth of the bayou. A prolonged drought, from April until after operations were suspended, put the stream at the lowest known stage, exposing obstructions in the channel, and affording the best opportunity for their removal since the project for improvement of navigation was undertaken by the United States.

Leaning timber was felled, cut into short lengths, and so disposed of as to dry out and not become future snags. Stumps within the banks were cut close to the ground or blown up, and sharp points, bends, and caving or sliding banks were well cleared of timber and brush. What are known as the "Round Turns" above Point Pleasant, La., difficult places for steamboats, were cleared for some distance back from the bayou. Certain kinds of timber, which sinks when green, are girdled and deadened before felling, but this had been done to a great extent along Bartholomew in former years. Nearly all dead trees were felled, however, especially those apt to fall toward or into the stream. Snags, logs, trees, and stumps in the channel were hauled out on the banks and cut up whenever practicable, and those too large or too strongly embedded in the bottom to be disposed of in this way were destroyed with dynamite, which was used freely for the purpose.

The stream was much obstructed by fallen timber, many of the trees almost reaching from bank to bank, and the bottom was covered with a thick network of snags, logs, stumps, trees, and brush. At places where the accumulations were greatest and most firmly embedded, sand bars had formed with pools above, and when the obstructions were removed or destroyed a stiff current set in at once, followed by a rapid scour on the bars, which lowered perceptibly from 1 to 3 feet in a day or two. Notable instances of this kind were at the bars just above Parkdale, Ark., below Wilmot, Ark., just above the Louisiana and Arkansas line, and at Wells Place, La.

The following is a summary of the work done from July 1 to October 17, 1896; viz:

Channel snags cut and destroyed	10,610
Stumps cut and destroyed	1,800
Shore snags cut and destroyed	1,162
Logs cut and destroyed	4,923
Leaning trees cut and destroyed	5,509
Trees girdled	90
Square yards willows and brush cut	18,809

The available balance was reserved to send one of the snag boats belonging to the district over the stream as soon as practicable to remove drift, etc., and in June, 1897, the U. S. snag boat *Columbia*, Watkins Decker, master, while making a patrol of Ouachita River and tributaries, entered this stream and was employed June 10 and 11. The stage was too low to go above Marble Landing, about 20 miles from the mouth, and further work had to be deferred until a rise. Seven snags were removed in this stretch.

The master of the *Columbia* reported that the banks were caving badly as far up as the boat went, and that a snag boat should go over the stream as soon as the stage is favorable.

The work of the past two years has been done thoroughly, and practically completes the project adopted in 1881 for the removal of leaning timber, wrecks, snags, stumps, sunken logs, etc., to lengthen the period of navigation and give ease and safety to the passage of boats from Ouachita River. The stream was put in safe navigable condition to McComb Landing, Ark., the present head of navigation, and there is no demand for work above the latter place at the present time.

The improvement attained, however, can not be considered as permanent. Drift from above, sliding and caving banks, and the rapid growth of vegetation, will add new obstructions, which will accumulate more rapidly each year. Bayou Bartholomew is the largest tributary to the system of rivers forming the Ouachita Basin, now being surveyed with a view to slack-water navigation, and it is estimated that it will cost about $2,500 a year to maintain unobstructed navigation at stages when steamboats can run. To complete the original project by carrying operations above McComb Landing to Baxter probably will cost about $10,000 additional, as estimated in my last report.

Money statement.

July 1, 1896, balance unexpended	$5,586.65
June 30, 1897, amount expended during fiscal year	4,460.18
July 1, 1897, balance unexpended	1,126.47
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	2,500.00

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1881	$8,000	July 13, 1892	$5,000
August 2, 1 82	5,000	August 18, 1894	5,000
July 5, 1884	5,000	June 3, 1896	4,000
August 5, 1886	5,000		
August 11, 1888	5,000	Total	47,000
September 19, 1890	5,000		

COMMERCIAL STATISTICS.

Bayou Bartholomew was reported navigable from January 1 to May 20 in the past fiscal year.

List of steamboats engaged in navigation during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*		
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2 0	4 6	Monroe and Desiard, La.	1
Le Vere	Stern-wheel.	98.73	109.2	23.9	2.9	1 0	2 6	Monroe, La., and Portland, Ark. Monroe and Elder, La.	11 13
Belle of D'Arbonne	...do..	74.59	111	22	3.7	2 0	4 0	Monroe, La., and various landings.	12

Summary of commerce reported.

Articles.	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	175	1,235	1,390	2,434	1,000	2,372	3,971	2,000
Cotton seed	9,040	270	3,826	2,991	1,300	3,326	2,467	4,000
Cotton-seed meal	....	....	....	....	....	1,425	516	....
Saw logs	2,020	7,683	....	159	2,000	4,450	20,080	11,839
Staves	2,165	6,012	117	2,569	2,375	1,648	17,822	....
Miscellaneous	224	350	100	665	175	410	1,340	....
Total down freight	13,624	15,550	5,433	8,818	6,850	13,631	46,196	17,839
Return freight	615	2,110	1,200	3,469	825	1,534	3,103	4,000
Total	14,239	17,660	6,633	12,287	7,675	15,165	49,299	21,839
Estimated value	$97,000	$561,000	$243,000	$564,000	$136,000	$515,000	$826,000	$492,700

The country along Bayou Bartholomew was drought stricken from April, 1896, until near the end of the calendar year, Morehouse Parish having been the drought center, which accounts for the marked shrinkage of values. The impoverished people had to market their seed cotton, the only article showing an increase during the year.

This stream is crossed at Baxter, Ark., the upper limit of improvement, by a branch of the St. Louis, Iron Mountain and Southern Railroad, which connects with the Mississippi River at Arkansas City, Ark., runs west 56 miles to Warren, Ark., and probably will be extended to Camden, on the Ouachita, which is connected with the main line by a branch to Gurdon, Ark. The Houston, Central Arkansas and Northern Railroad (another branch of the Missouri Pacific system) runs parallel to Bartholomew from McGehee, Ark., to Monroe, La. The New Orleans and Northwestern Railway, completed to near Bastrop, La., crosses the Houston, Central Arkansas and Northern Railroad at Collinston, 7 miles south of Bastrop. A new line from Sunnyside Landing, Ark., on the Mississippi River, to Hamburg, Ark., crossing Bayou Bartholomew near Portland, Ark., is projected.

U 6.

IMPROVEMENT OF BŒUF RIVER, LOUISIANA.

With exception of the closure of three outlets near Point Jefferson, the project for this work was completed in 1896. The amount of the last appropriation was not sufficient to close these outlets, and for this reason it was recommended that its expenditure be deferred for the present. The correspondence upon the subject is given in full below:

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., June 23, 1896.

GENERAL: In compliance with directions contained in letter from your office dated 19th instant, I have the honor to report respecting the expenditure of the appropriation by river and harbor act of June 3, 1896, of $6,000 for continuing improvement of Bœuf River, Louisiana, as follows:

This work was commenced in 1881. At that time the stream was navigable at high stages from its mouth to Point Jefferson, La., about 133 miles above, but the passage was difficult and dangerous on account of snags, logs, and leaning timber. The project contemplated removing these obstructions to afford reasonably safe navigation to Wallace Landing, about 19 miles above Point Jefferson, for light-draft boats during the period of high water, or for about five months of the year. Major Benyaurd, who prepared the project, proposed to do the work then required in two successive seasons at a cost of $20,000. No estimates for maintenance were made. Small and intermittent appropriations and the addition of new obstructions each year increased the cost and prevented thorough work and its completion as planned. Operations continued from time to time as funds were available, and the thorough work of the past two years practically completed the project for giving ease and safety to high-water navigation, and made a great change in the condition of the stream. There is scarcely any leaning timber left, and snags, logs, stumps, etc., have been removed from the channel until steamboats can run safely at any stage high enough to permit them to cross the bars; saving at least thirty-six hours on the round trip.

The improvement will not be permanent, however, on account of obstructions added by drift from above Wallace Landing, floods, sliding banks, and the rapid growth of vegetation along an alluvial stream. If no provision is made for maintenance, the river soon will return to its former obstructed condition and the work of fifteen years will have been lost. The annual expenditure of about $2,500 would appear to be warranted for maintenance, and it is recommended that the project be modified to this extent.

The closure of three outlets near Point Jefferson was recommended in 1884, at a cost of about $7,300, as necessary to preserve navigation of Bœuf River, and this addition to the project was authorized by river and harbor act of 1886, which, however, failed to provide sufficient means for the purpose. But by uniting with the planters whose lands would be protected, the outlets were closed in 1887–88, the proportion of cost borne by the United States having been $5,441.78. Outlet No. 1 was closed substantially, the second outlet was closed by a heavy dam, and the third by a low dam, which was all the work that could be done with the insufficient appropriation and the assistance rendered by the planters. This work gave immediate benefit to navigation by confining the flow to its natural course, scouring the bars in the channel below, but during the overflow from Mississippi River in the spring of 1890, caused by breaks in the Arkansas levees near the head waters of Bœuf River, letting the flood through the crevasses down Bœuf and Tensas valleys, all the dams were swept away. In the spring of 1893 I sent an assistant to make an examination of the outlets and the old connecting levees between them, the results of which, briefly, were as follows: The dam at Outlet No. 1 was washed away to about the height of ordinary low water, except the south wing; the dam at No. 2 was standing, but the old levee and bank on the west side showed a deep wash below low water, and the dam at No. 3 was gone. The latter was not expected to withstand such a flood, but if appropriation had been made according to the original estimate for closing all three outlets at the same time, it would have been raised above high water and done much to insure the safety of all three. All the outlets should be closed and connected by a levee at least 3 feet above highest water. The cost of the work was given in my report of 1893 at $30,000, with the recommendation that nothing be done until a specific appropriation was made for the purpose, which has been repeated each year since. The outlets are a serious injury to navigation of the river. Channel soundings taken during a reconnaissance made in March of this year showed depths ranging from 8 to 11 meters in the stretch immediately above the outlets, and only 2.5 meters to 3.2 meters in the stretch immediately below, at a stage about 2.7 meters above low water. Since the dams closing the outlets were destroyed much work has been done by the United States and the Tensas Basin Levee district to restore, enlarge, and strengthen the levee system on Mississippi River; the protection of the Tensas Basin Levee district from Arkansas River to Red River depending mainly upon the security of the levees in Chicot and Desha counties, Ark. The last report of the board of state engineers of Louisiana, dated April 20, 1896, states:

"Of the extensions needed, the most important appear to be at the upper and lower ends of the line now existing from the Costello place in Desha County, Ark., to Bougere Landing, in Concordia Parish, La. This line should either be extended farther up Amos Bayou Ridge, or else the levees on the Arkansas River should be extended down to near the mouth of Cypress Creek; and the old levees on the Arkansas, from Red Fork nearly up to Pine Bluff, should also be in great part relocated and renewed, and all greatly enlarged."

The funds available are not sufficient to close the three outlets, and it will be unwise to commence work until all can be closed without delay. To close any one of them alone would waste the money and invite disaster. No help can be expected from the State, the parish, or individuals, and it would be unreasonable to expect help from a people who have been almost ruined by the criminal neglect of another State to do its part toward restraining the floods of Arkansas and Mississippi rivers.

There is an unexpended balance of $2,565.38 of the appropriation of 1894 for improving Bœuf River, which will be sufficient for maintenance of the work done for a year at least, and while the outlets should be closed as early as possible, it is recommended, for the reasons stated herein, that the project for expenditure of the appropriation by act of June 3, 1896, be held in abeyance for the present.

Bœuf River is tributary to the system of rivers of the Ouachita Basin, which is now being surveyed with a view to slack-water navigation. The improvement of its navigation is worthy to be continued by the United States.

Very respectfully, your obedient servant,

J. H. Willard,
Major, Corps of Engineers.

Brig. Gen. W. P. Craighill,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

Office of the Chief of Engineers,
United States Army,
Washington, D. C., July 3, 1896.

Major: Your letter of the 23d ultimo, respecting project for application of appropriation of $6,000 made by the river and harbor act of June 3, 1896, for improving Bœuf River, Louisiana, recommending that the project for expenditure of the appropriation be held in abeyance for the present is received.

Your recommendation is approved.

Very respectfully, your obedient servant,

A. Mackenzie,
Acting Chief of Engineers.

Maj. J. H. Willard,
Corps of Engineers, U. S. A.

Work for maintenance of the improvement by removing obstructions brought into the stream since operations were suspended in March, 1896, was not resumed during the fiscal year until June 15, 1897. The U. S. snag boat *Columbia*, Watkins Decker, master, entered the mouth that date and worked up to Alto, La., about 100 miles above, by June 19. The river was found to be in good navigable condition, except for a few floating butts and caved-in trees, 47 being removed on the trip. The lower 50 miles was overflowed by backwater from Ouachita River, but above that point the banks were coming out, and by the time Alto was reached the water was falling about a foot a day. The boat could go no higher with safety and was withdrawn June 21.

Money statement.

July 1, 1896, balance unexpended	$8,565.38
June 30, 1897, amount expended during fiscal year	236.92
July 1, 1897, balance unexpended	8,328.46
Amount (estimated) required for completion of existing project	24,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899: For closing outlets, $24,000; for maintenance, $2,500	26,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

The following appropriations have been made:

By act of—		By act of—	
March 3, 1881	$5,000	July 13, 1892	$10,000
August 2, 1882	5,000	August 18, 1894	8,000
July 5, 1884	5,000	June 3, 1896	6,000
August 5, 1886	5,000		
August 11, 1888	6,000	Total	55,000
September 19, 1890	5,000		

COMMERCIAL STATISTICS.

Bœuf River was reported navigable from December 1, 1896, to June 30, 1897. The Vicksburg, Shreveport and Pacific Railroad Bridge, near Girard, La., was considered the head of navigation.

List of steamboats engaged in navigation in the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		From—	Round trips.
						Light.	Loaded.		
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*		
Parlor City	Stern-wheel.	136.30	125	26	3.7	2 0	5 0	Monroe, La	1
Stoneware	...do..	74.21	100	17	3	2 2	3 6	New Orleans, La	1
G. W. Lyon	...do..	86.17	115	22	4.4	......	......	.....do	2
City of Brunswick	...do..	77.01	87.9	19.6	3.9	......	......	.....do	1
Dixie	...do..	16.94	52.6	12	4	......	......	.....do	1
Lee Otis	Tug...	4.5	40	9	5	4 6	4 6	Stafford Point, La. (local towing).	....
Julia H	...do..	4.9	35	7	.....	4 0	4 0	Mouth to Alto, La Mouth to Jones Landing, La.	5 24
Irwin	L'nch.	3	35	8	.....	2 6	3 2	Stafford Point, La. (local towing).	....

Summary of commerce reported.

Articles.	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	130	707	876	900	626	1,583	1,760	1,397
Cotton seed	188	1,633	2,313	2,550	1,878	1,178	716	731
Hides and skins	1	8	1	....	....	50	....	....
Live stock	....	61	76	12	....	19	....	....
Lumber	23	1,100	75	300	250	1,352	....	....
Saw logs	....	840	....	....	....	1,223	....	....
Staves	10,675	4,000	1,389	4,626	923	3,138	1,777	263
Miscellaneous	20	190	136	450	300	72	179	....
Total down freight	11,037	8,542	4,866	8,838	3,977	8,615	4,432	2,391
Return freight	224	425	250	650	335	1,370	3,458	1,594
Total	11,261	8,967	5,116	9,488	4,312	9,985	7,890	3,985
Estimated value	$69,000	$270,000	$159,000	$350,000	$200,000	$501,000	$636,500	$580,850

The marked shrinkage in values during the year was due to the protracted drought in the parishes along Bœuf River, which destroyed the crops.

The Vicksburg, Shreveport and Pacific Railroad crosses Bœuf River near Girard, La., and the New Orleans and Northwestern Railway crosses about 2 miles north of Rayville, La. The Houston, Central Arkansas and Northern Railroad runs parallel to the river on the west, and a line is projected (Louisiana, Arkansas and Missouri Railroad) which will touch the river at several points on the east.

U 7.

IMPROVEMENT OF TENSAS RIVER AND BAYOU MAÇON, LOUISIANA.

There is no plant belonging to this work, and, as the amount available was small, it was intended to use the quarter boat and outfit employed in Bayou Bartholomew and Upper Ouachita River to save the expenditure of a considerable proportion of the appropriation for a new boat, tools, organization of working party, etc. By the time the plant could be spared for the purpose, however, both Tensas and Maçon were too high for effective work. For these reasons nothing was undertaken during the fiscal year until the latter part of June, 1897, when the U. S. snag boat *Columbia*, Watkins Decker, master, was making a patrol of Ouachita River and its tributaries.

The *Columbia* entered Tensas River June 22, continued upstream to mouth of Bayou Maçon, about 40 miles above, and up the Maçon about 60 miles to Crockett Point. Both streams were found in good navigable condition at the stage, and only five channel snags were removed June 22–25, when the boat was withdrawn. The lower 5 or 6 miles of Bayou Maçon are obstructed by leaning timber. Above that the brush under the banks should be cleared so as not to impede passage of drift, heavy trees deadened in former years should be felled and cut up, and snags and logs embedded in the bottom should be removed. Steamboat men say they could run to mouth of the Maçon with profit the year round if the bottom of Lower Tensas was cleared of snags and logs. These can not be located and destroyed except at lowest stages, but attention will be given the matter when work is resumed.

For works of this class it would be a measure of economy to provide a liberal sum to free the channel of snags and logs and clear the banks for some distance back, thereby lessening the source of obstructions.

The work once thoroughly done could be maintained by small expenditures from time to time, and for the latter purpose a permanent provision for snagging operations in Ouachita River and its principal tributaries probably would be the most advantageous method.

The original project recommended an expenditure of $40,000 for thorough work in one low-water season. Operations have dragged along for sixteen years with small and intermittent appropriations, permitting removal of the worst obstructions only from time to time. The last work, September, 1894, to January, 1895, put Bayou Maçon below Floyd and Tensas River below Westwood Place in fairly good navigable condition for the time. Drift brought down by floods, caving and sliding banks, and the rapid growth of timber and brush add obstructions every year, which should be removed in the interest of safe navigation.

Money statement.

July 1, 1896, balance unexpended	$5,146.30
June 30, 1897, amount expended during fiscal year	165.48
July 1, 1897, balance unexpended	4,980.82
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	4,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1881	$3,000	July 13, 1892	$5,000
July 5, 1884	4,000	August 18, 1894	5,000
August 5, 1886	4,000	June 3, 1896	5,000
August 11, 1888	5,000		
September 19, 1890	5,000	Total	36,000

COMMERCIAL STATISTICS.

In the fiscal year Tensas River was reported navigable to Tensas Bluff and Bayou Maçon to Floyd from July 1 to August 1, and from December 15 to June 30.

List of steamboats reported navigating Tensas River and Bayou Maçon in the fiscal year 1897.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft. Light.	Draft. Loaded.	Between—	Round trips.	Passengers.
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
T. K. Green	Stern-wheel.	32.77	81.8	17.3	3.1	1 0	3 0	Trinity and— Tensas Bluff Bayou Maçon Lower Tensas River.	 20 25 50	100
J. W. Swayzie	do							Jonesville and— Floyd	 25	
E. H. Barmore	do	171.47	135.7	30.1	5.4	2 6	5 0	Bayou Maçon	2	
Ramos	do	18.81	60.2	11.5	6			Bayou Maçon	4	
Sterling White	Side-wheel.	117.09	120	30.5	4.2	2 6	4 6	Floyd	7	

Summary of commerce reported.

Articles.	1896-97.	1895-96.	1894-95.	1893-94.	1892-93.	1891-92.	1890-91.	1889-90.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	1,310	1,038	1,548	450	498	3,762	2,760	1,527
Cotton seed	3,544	2,444	2,993	1,400	1,457	4,876	4,850	2,920
Hides and skins	2	....	50	2	3	....	10	2
Live stock	200	....	290	108	3	10	6	....
Staves	10,321	285	260	895	26	71	1,082	3,325
Lumber	400	640	4,012	300	....	440	....	....
Miscellaneous	100	150	1,045	104	....	1,942	378	50
Saw logs	5,000	....	....	....	....	....	....	....
Total down freight	20,877	4,557	10,198	3,259	1,987	11,101	9,086	7,824
Return freight	1,419	272	2,092	2,700	662	5,886	6,000	5,216
Total	22,296	4,829	12,285	5,959	2,649	16,987	15,086	13,040
Estimated value	$535,000	$146,000	$561,000	$389,000	$122,500	$990,000	$999,500	$742,890

The Vicksburg, Shreveport and Pacific Railroad crosses Bayou Maçon near Delhi, La. The New Orleans and Northwestern Railroad crosses Tensas River at Clayton, Concordia Parish, La.

U 8.

IMPROVEMENT OF YAZOO RIVER, MISSISSIPPI.

In July and August, 1896, needed repairs of the U. S. snag boat *John R. Meigs* were made at Vicksburg. P. R. Starr, master of the vessel, was sent to Ouachita River September 7, for temporary duty on the U. S. steamer *Columbia*, and returned to Vicksburg September 16. The following day the *Meigs* ran to mouth of Yazoo River, Vicksburg gauge reading 4.5 feet, falling, and that at Yazoo City reading 2.3 feet below zero. The usual conditions of a low stage were found, the channel running through a shifting quicksand for a distance of 2 miles or more above the entrance into the Mississippi, with depth varying from 6 to 20 inches. Finding it would be impracticable to send the boat into the Yazoo, it was transferred for temporary use in Red River, and did not return to Vicksburg until December 13. By the time it was overhauled and repaired the period of high water had set in, and it was not advisable to attempt snagging operations. During the great flood of the Mississippi, in March and April, 1897, the snag boat *Meigs* and the snag boat *Florence* were used on the Mississippi and Yazoo and tributaries of the latter by the Subsistence Department for saving life and property, distributing rations, etc., under act of Congress approved April 7, 1897, for relief of overflow sufferers. This prolonged flood kept the stages of Yazoo River too high for advantageous work until June, 1897, when the *Meigs* had to be used to tow a dredge from Vicksburg to work in Cypress Bayou. On its return to Vicksburg, in July, it is proposed to send the snag boat into Yazoo River.

August 10, 1896, the superintendent of the Yazoo and Tallahatchie Transportation Company reported that their steamer *John F. Allen* had been detained seven hours by obstructions caused by a sunken flatboat at Rosebank, just above head of Honey Island, and, at his request, Overseer Robert Elflein made the trip from Vicksburg to Greenwood

August 11–14, taking a battery and explosives to destroy the obstructions complained of. Part of the wreck of a flatboat and three logs in the channel at Rosebank were destroyed, enabling boats to pass without detention. Five logs in the channel at French Bend and a stump in the channel at head of Honey Island also were blown up.

The party which had been working in Tallahatchie River, under supervision of Overseer John Schuh, reached the mouth of that stream September 24 and continued down the Yazoo. September 25–December 5, 1896, operations were carried to Allen Miller Landing, estimated to be a distance of about 60 miles. During this period the water was extremely low, said to have been the lowest known in Upper Yazoo, and the stages at Yazoo City were below zero on the gauge until December 2, the readings ranging between —1 and —2.8 feet.

The party was equipped with axes, saws, tackle, and explosives, and did effective work, which has been much commended by steamboat men. Tree slides were removed from the channel, the banks were cleared of leaning timber and brush, and all snags, logs, stumps, etc., in the channel that could be located were pulled out or blown up. In front of Greenwood the channel was much obstructed by sunken saw logs. At the upper landing it was difficult for steamers to get near enough to put out stage plank, and at the lower end of town there was scarcely a place where boats could land. The logs were pulled out or destroyed with explosives, and a fair channel soon scoured. Below Greenwood the banks were covered with a heavy growth of trees and brush, the channel at low water was much obstructed by snags at places, and heavy trees and stumps, which had caved and slid into the river, were numerous.

The following is a summary of the work reported, viz:

Channel snags pulled, cut, and destroyed	9,739
Stumps pulled, cut, and destroyed	10,630
Logs pulled, cut, and destroyed	10,834
Shore snags cut and destroyed	9,072
Leaning trees cut and destroyed	24,181
Leaning trees topped	1,738
Trees girdled	50,819
Square yards willows and brush cut	2,294
Side jams removed	3
Wrecks removed: Part of sunken flatboat at head of Honey Island, and three hogchain braces from wreck of steamer *Birdie Bailey*.	

A rise of the river necessitated suspension of operations December 5, and a heavy rainfall on the 7th and 8th brought it to so high a stage that it was deemed advisable to stop work until the winter flood had passed. December 10–16 the quarter boat was dropped down to Vicksburg and laid up with the plant in Lake Centennial.

The recommendations and estimates contained in my reports of 1894, 1895, and 1896 respecting the streams of the Yazoo system are repeated, viz:

> Work in Yazoo and tributary streams could be carried on more economically if they were grouped together as a system and appropriations made under one head, with allotments for each stream. The plant could then be bought from the general appropriation and its use charged pro rata without being a heavy burden upon any one stream. A modern dredge, preferably self-propelling, would be of great use in parts of Yazoo, Tchula Lake, and Big Sunflower, but the largest appropriation of late years for any one of the streams mentioned would not be sufficient for the purpose. So also with regard to pile drivers, quarter boats, or small hand-snagging outfits, the idea being to have a district plant, to be used on any of the streams of the system when needed. The estimates are made with this view, the work required not being of a kind that can be done advantageously or satisfactorily by contract

A great deal of work remains to be done in clearing the banks of leaning timber to prevent tree slides and snags and to make the passage of the sharp bends safer, and this can be done most economically by shore parties housed and subsisted on quarter boats, leaving the heavy work to be done at the proper or convenient time by the snag boats. There are also many places where the channel is injured by dispersion, and where chutes should be closed or wing dams built. As Yazoo and tributaries are not subject to heavy drift, work of the kind need not be expensive, and probably sheet piling would answer very well.

DETAILED ESTIMATES.

General service plant:		
Dredge	$30,000	
Pile driver	4,000	
Quarter boats	2,500	
Skiffs, tools, rigging, etc	3,500	
		$40,000
Service of plant:		
Expenses of snag boats	24,000	
Expenses of dredges	9,000	
Expenses of shore parties	7,000	
		40,000
Care of plant:		
New boilers	4,000	
Hull repairs	3,000	
General and extraordinary repairs	1,500	
Fleet, wages, supplies, etc	1,500	
		10,000
Surveys: Local surveys, gauges, discharge measurements, etc		6,000
Administration:		
Office expenses, rent, supplies, etc	1,500	
Assistant engineers, draftsmen, transportation, and incidentals	2,500	
		4,000
Total		100,000

Money statement.

July 1, 1896, balance unexpended	$34,559.87
June 30, 1897, amount expended during fiscal year	6,923.00
July 1, 1897, balance unexpended	27,636.87

Amount that can be profitably expended in fiscal year ending June 30, 1899 100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1873	$40,000	August 5, 1886	$15,000
March 3, 1875	12,000	August 11, 1888	32,000
August 14, 1876	15,000	September 19, 1890	25,000
June 18, 1878	25,000	July 13, 1892	20,000
March 3, 1879	15,000	August 18, 1894	20,000
June 14, 1880	12,000	June 3, 1896	20,000
March 3, 1881	6,000		
August 2, 1882	8,000	Total	275,000
July 5, 1884	10,000		

COMMERCIAL STATISTICS.

Above the mouth this river was navigable the entire year. The mouth was unnavigable September 12–November 13, 1896. Small boats entered the river the latter date, though navigation across the bar was difficult until higher stages.

List of steamboats engaged in navigating Yazoo River during the fiscal year.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
Atlanta	Stern-wheel.	85.08	93	16.4	3.7	1 10	3 6	Yazoo City and Silver City.	16	128
John F. Allen	do	133.9	130.2	24	4.2	1 8	4 0	Vicksburg and— Greenwood	17	57
								Tallahatchie River	30	289
Birdie Bailey	do	109.7	111	22	3.5	1 10	4 0	Yazoo City and Belzona.	6	239
Hibernia	do	157.06	135	25	4	2 0	4 0	Vicksburg and— Tallahatchie River	1	15
								Big Sunflower River.	4	23
								Yazoo City	3	27
								Yazoo City and— Sartatia	2	9
								Belzona	16	313
Yasonia[a]	do	62.84	95	19.8	3.5	1 8	3 6	Vicksburg and Greenwood.	3	19
								Greenwood and Tallahatchie River.	22	220
								Yazoo City and— Big Sunflower River.	30	240
								Greenwood	8	48
								Belzona	11	195
Rees Pritchard	do	196.2	150.3	31	3.3	1 9	4 0	Vicksburg and— Tallahatchie River	10	113
								Greenwood	14	76
								Yazoo City	2	15
								Yazoo City and Belzona.	20	260
Maggie[a]	do	50.73	85	19	3.5	1 6	3 0	Greenwood and Tallahatchie River.	22	209
								Yazoo City and— Big Sunflower River.	27	197
								Silver City	4	13
E. A. Pharr[a]	do	63.61	90	29.9	4.2	2 2	3 6	Sheppardtown and Coldwater River.	80	720
Josephine Lovizа[b]	do	95	113.6	22.2	3.7	2 4	3 6	Vicksburg and— Callao	1	......
								Belzona	1	......
								Steele Bayou	1	......
Ferd. R.[a]	do	45.5	93	16	3	1 1	3 0	Yazoo City, Belzona, Tokoby, Tchula Lake, and Big Sunflower River.	52	......
Lake Palmyra	do	141	123.5	26	4.8	2 6	4 6	Vicksburg and Big Sunflower River.	28	......
Mary Joyce[a]	do	34.64	65	14	2.4	1 1	2 0	do	2	......
Novelty[a]	do	63.4	76.4	16.4	3	1 6	3 6	do	38	500
Water Maiden[a]	do	23.13	69	12	2.6	1 11	2 0	do	8	10
Morning Star	do	46.51	95	20.4	2.4	2 2	3 0	do	1	......
Fifteen[a]	do	75	103	18	3.5	1 8	3 0	Greenwood and Tallahatchie River.	20	197
								Yazoo City and Big Sunflower River.	66	462
Mima[a]	do	62.72	66	17	3.2	1 6	1 6	Vicksburg and— Big Sunflower River.	4	......
								Steele Bayou	3	......
Alarm[b]	do	189.09	142	26	4.3	......	......	Big Sunflower River.	1	......
May Flower	do	19.07	64.3	15.6	6.7	......	......	do	1	......
Mildred[a]	do	19.76	54.5	11	3.2	......	......	do	2	......
								Steele Bayou	1	......
Thomas A. Hendricks.[b]	do	81.86	108	22.5	4.2	4 2	5 0	Tallahatchie River	1	......
L. L. B.	do	6.54	36.6	16.7	2.8	1 10	1 10	Shellmound	1	......
Electric	do	34.57	77.6	20	2.8	......	......	Greenwood	1	......
Cruiser[b]	do	240.06	152	30	5	......	......	Yazoo City	2	......
Wash Honshell[b]	do	134.99	157	28.6	4	......	......	Vicksburg and——	1	......
Memphis[a]	do	110.28	111	26.6	4	......	......	Vicksburg and Greenwood.	1	......
Joy Patton[b]	do	63.04	100	21.3	5.6	3 6	4 0	New Orleans and——	1	......

[a] With one or more barges.

[b] Towboat.

List of steamboats engaged in navigating Yazoo River during the fiscal year—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
Joe Seay	Tug	27.74	75	16	7	6 0	8 0	Vicksburg and Greenwood. Vicksburg and short distances above mouth.	1 6	....
J. B. O'Brien[a]	do	44.49	70.8	15.2	7	7 6	9 0	Vicksburg and short distance above mouth.	1	......
Bertie C.[a]	do	......	......	......	......	......	......	Local trips from Greenwood.	....	......
Mary T.[a]	Launch	......	......	......	......	......	......	do	....	......

[a] With one or more barges.

The following light-draft barges were used in the trade: *Sunlight*, 150 tons; *Fred Lloyd*, 165 tons; *Life Buoy*, 150 tons, *Geo. W. Bookout*, 125 tons.

Summary of commerce reported.

Articles.	1896–97.	1895–96.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	21,163	14,408	17,087	15,815	11,094	15,653	13,750
Cotton seed	32,147	17,150	19,482	17,355	12,795	16,570	12,500
Hides and skins	12	12	11	10	26	19	10
Live stock	120	52	47	60	79	124	60
Lumber	2,450	1,613	10,080	3,200	3,122	3,318	3,600
Staves	14,264	23,740	10,623	14,447	12,488	6,864	1,850
Provisions	14,175	13,520	13,325	12,020	8,547	10,502	9,020
Grain	7,380	7,018	13,760	14,280	6,107	12,531	11,080
Saw logs	40,200	31,200	11,000	22,400	11,800	15,000	2,140
Miscellaneous	15,400	18,858	17,725	12,200	8,507	12,624	10,540
Total freights for Yazoo proper	147,311	127,571	113,040	111,787	74,565	93,205	64,050
Total freights from tributaries	57,546	85,374	107,551	136,394	124,887	116,021	97,588
Total freights Yazoo and tributaries	204,857	212,945	220,591	248,181	199,452	209,226	161,638
Estimated value	$3,218,000	$3,619,000	$4,806,000	$8,314,000	$4,829,000	$7,851,500	$6,315,275

Receipts and shipments of bales of cotton at Greenwood and Yazoo City, Miss., during the fiscal year 1897.

Greenwood.			Yazoo City.		
Routes.	Receipts.	Shipments.	Routes.	Receipts.	Shipments.
Southern Rwy	9,962	19,962	Illinois Central R. R	13,353	56,102
Illinois Central R. R	4,521	17,006	River	22,618	2,309
River	20,808	896	Wagon	23,292	....
Wagon	2,500	....	Total	59,263	58,411
Total	37,791	37,864			

When the mouth of the river is closed to navigation, the sources of supplies for Yazoo and tributaries are Yazoo City and Greenwood.

The Georgia Pacific Division of the Southern Railway crosses Yazoo River at Fort Loring, 5 miles below Greenwood, and the Yazoo and Mississippi Valley Railroad crosses about 15 miles above the mouth. The latter has a branch from Clarksdale to Philipp, on the Tallahatchie, connecting with a branch of the Georgia Pacific to Greenwood. The Yazoo branch of the Illinois Central Railroad, from Parsons, on the Yallabusha, to Jackson, Miss., runs parallel to the river, touching at Greenwood, Sidon, Tchula, and Yazoo City, and has a tap line from Tchula to the main line at Durant.

U 9.

IMPROVEMENT OF MOUTH OF YAZOO RIVER AND HARBOR AT VICKSBURG, MISSISSIPPI.

Operations during the year were as follows:

July 1–August 10, 1896, the work of freeing the line of proposed excavation of tree trunks, stumps, etc., was completed by a force of laborers hired for the purpose. During this period the débris was cut, piled, and burned on Stations 160–167 and 183–191, between Old River and Lake Centennial.

June 17, 1896, I forwarded to the Department, through the division engineer, a recommendation for the removal by contract of about 150,000 cubic meters (196,200 cubic yards) of earth from the land cut, for the purpose of reducing the surface grade; completing grubbing and exposing clean soil; commencing foundations of a system of levees on both sides of the cut to a height sufficient to prevent material washing back in case hydraulic dredging should be adopted for the diversion route, at the same time saving cost of rehandling earth for levee work; and to permit attacking higher ground, when dredging is undertaken, at lower flood stages than would be possible, and generally to greater advantage according to changing stages.

My recommendation was approved July 6, the work was advertised July 10, and bids were opened July 25, 1896, an abstract of which is hereto appended. Contract with the lowest bidder, Mr. A. P. Martin, of Waterproof, La., at the rate of 19⅜ cents per cubic meter, was entered into August 5 and approved by the Chief of Engineers August 11, 1896, requiring work to commence by August 17 and to be completed by December 31, 1896. Under authority of the Chief of Engineers dated December 26, 1896, upon my recommendation, the time for completion was extended to April 30, 1897.

The description of the work in the specifications was as follows:

> The work to be done consists of excavating about 130,000 cubic meters, more or less, between Stations 134 and 168 on the old bank of Mississippi River on Lake Centennial for a width of about 140 meters to a level grade, the depth ranging from 0.3 to about 1.2 meters. The distance from the middle line of the cut to the inner foot of the slope of the embankment on either side will not be less than 170 meters. The earth must be hauled to either side of the cut and deposited in a continuous spoil bank, sloped in the same manner as in levee work, the slope, however, depending upon the height to be given the embankment which must be kept at a regular grade. The work at the Old River end will be between Stations 186 and 192, and will be about 180 meters in width by a depth ranging from one-half to 1 meter. The amount of excavation is estimated at about 20,000 cubic meters, more or less. The distance from the middle line of the cut to the foot of the slope on either side must not be less than 190 meters. The excavation must be carried to a uniform grade and the embankment put up in the same way as for the cut at the lake end. The material excavated will be measured in its original place and so paid for at the accepted price per cubic meter, which price shall cover all cost of the work.

The contractor commenced operations August 17, 1896, and continued until March 5, 1897, when his force was driven off the work by flood water from the Mississippi. March 8 he and his sureties applied for release from further work under the contract, and in view of the fact that work was stopped by the high stage of the Mississippi, and that the prospect of continued flood made it necessary to move the plant to a secure locality, it was not considered just to require the contractor to return at some future indefinite time, inasmuch as the general object sought had been attained, and, under date of March 20, the Secretary of War authorized supplemental articles of agreement terminating the contract, which were entered into April 2, approved by the Chief of Engineers April 8 and by the Secretary of War April 23, 1897.

Final measurement of the work showed the total amount completed under the contract to be 123,227 cubic meters (161,181 cubic yards); 89,114 cubic meters (116,561 cubic yards) between Stations 134 and 168 at Lake Centennial end, and 34,113 cubic meters (44,620 cubic yards) between Stations 186 and 192 at Old River end.

The condition of the work at end of thė year is summarized as follows:

Work done.—Surveys and mapping; reference signs erected, 317; land purchased, 468.05 hectares (1,156.54 acres); timber land cleared, 67.26 hectares (166.20 acres); timber land grubbed, 74.25 hectares (183.47 acres); right of way freed of logs and stumps, removed and destroyed, 40 hectares (98.84 acres); excavation, 212,316 cubic meters (277,709 cubic yards); drains and ditches, 5,165 cubic meters (6,756 cubic yards).

Approximate work to be done.—Excavation, 4,287,684 cubic meters (5,608,290 cubic yards); levees, 50,000 cubic meters (65,000 cubic yards); dam across west arm of Lake Centennial, 2,300,000 cubic meters (3,008,400 cubic yards).

On February 11, 1897, I submitted a project for operations by the method called continuous contracts. The work to be advertised was to be contract No. 3, and to cover excavation, by any method the contractor might choose, of the line of canal between Lake Centennial and Old River, depositing some of the material behind the embankments now raised upon the right of way on either side; part in the "wrong end of Old River" below the line of the canal, and part across Lake Centennial below the line of the canal from the west shore of the lake to the head of the former point of bend in Louisiana, now called De Soto Island; excavating and dredging from a point in the deeper water above the dam built by the Mississippi River Commission from the Vicksburg shore to De Soto Island; removal of part of the dam, and excavating and dredging along the line of the canal in front of Vicksburg, begun by the Mississippi River Commission, to deep water at Kleinston, the present lower steamboat landing for Vicksburg at stages below, say 25 feet on the Vicksburg gauge; the material to be deposited beyond and westward of the canal either in the lake or so far as not to slide in or weigh the banks to such an extent as to force up the bottom, on the line of deposit across Lake Centennial, if such deposit should be made, or wherever the engineer in charge may reasonably order; dredging or excavating in the "wrong end of Old River" from deep water to join the canal across to Lake Centennial, and deposit of material westward or below at safe distance.

It was proposed to require active operations to begin within ninety days after notice of approval of contract, with sufficient plant for an output of not less than 75,000 cubic meters (say 100,000 cubic yards), with increase of plant within three months from beginning to give an output of not less than 260,000 cubic meters (say 260,000 cubic yards) per month.

No action had been taken on this project to the end of the fiscal year. The work ought to be done within two years from the date of beginning, unless prevented by excessive floods.

Money statement.

July 1, 1896, balance unexpended	$207,565.05
Amount appropriated by sundry civil act approved June 4, 1897	350,000.00
	557,565.05
June 30, 1897, amount expended during fiscal year	33,413.70
July 1, 1897, balance unexpended	524,151.35
July 1, 1897, outstanding liabilities	22.83
July 1, 1897, balance available	524,128.52
Amount (estimated) required for completion of existing project	510,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	510,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

List of appropriations made.

Date of act.	Purport.	Amount.
July 13, 1892	Improving mouth of the Yazoo River, Mississippi, in accordance with plan of Capt. J. H. Willard, dated February 4, 1892, contained in House Ex. Doc. No. 125, Fifty-second Congress, first session, including borings and gauges. Should the Secretary of War be unable to obtain such right of way as may be necessary in the prosecution of this work, upon reasonable terms, by agreement, purchase, or voluntary conveyance, he is hereby authorized to apply at any term of the circuit or district court of the United States for the western division of the southern district of Mississippi, and in the name of the United States institute and carry on proceedings to condemn such lands as may be necessary for right of way as aforesaid, and in such proceedings said court shall be governed by the laws of the State of Mississippi, so far as the same may be applicable to the subject of condemning private property for public use.	$75,000
Aug. 18, 1894	Improving mouth of the Yazoo River, Mississippi, continuing improvement, to be expended in accordance with plan of Capt. J. H. Willard, as set out in House Ex. Doc. No. 125, Fifty-second Congress, first session	225,000
Do	Improving harbor at Vicksburg, Miss., not including work at Delta Point, Louisiana, continuing improvement under the direction of the Secretary of War	40,000
June 4, 1897	For continuing improvement of mouth of Yazoo River and harbor of Vicksburg	350,000
	Total	690,000

The river and harbor act of June 3, 1896, provided for completion of the work by the following item, viz:

Improving mouth of Yazoo River and harbor of Vicksburg, Miss.: For the purpose of completing the project of improvement as heretofore adopted and entered upon, in addition to expending the balance on hand, contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the same, or said materials may be purchased and work may be done otherwise than by contract, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $860,000, exclusive of the amount heretofore appropriated.

Payments for obligations that may be incurred under this act are limited by section 5, as follows:

SEC. 5. That under the authority to make contracts for materials and work, under the provisions of this act, in addition to the sums appropriated herein, the Secretary of War shall not obligate the Government to pay, in any one fiscal year, beginning July 1, 1897, more than $400,000 upon the said contracts for any one of the works herein placed under the contract system, except as herein otherwise specifically authorized to do: *Provided*, Any part of the annual allotment herein provided for, not earned and paid for material furnished or work done in one fiscal year, may be paid for material furnished and work done under the contracts in any subsequent fiscal year: *Provided further*, That nothing herein contained shall be so construed as to prevent the Secretary of War from making contracts for the whole or any part of the works placed under the contract system in such manner as may be deemed best, payments, however, to be made as stated in this section.

Abstract of proposals for about 150,000 cubic meters of excavation and embankment between Old River and Lake Centennial, near Vicksburg, Miss., received in response to advertisement dated July 10, 1896, and opened at Vicksburg, Miss., July 25, 1896, by Maj. J. H. Willard, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic meter.
		Cents.
1	Batt O'Brien, Memphis, Tenn	$27\frac{1}{2}$
2	A. P. Martin, Waterproof, La.[a]	$19\frac{3}{8}$
3	Manning & Gibson, Greenville, Miss	24
4	Charles H. Dameron, Huntsville, Mo	23
5	C. D. Leeper & Co., Baton Rouge, La	32
6	Michael O. Gorman, Vicksburg, Miss	$19\frac{3}{4}$
7	Bernard Conaghan, Vicksburg, Miss	$24\frac{11}{16}$

[a] Bid accepted.

COMMERCIAL STATISTICS.

During the fiscal year the canal or harbor from Kleinston to the city landing at the foot of Crawford street was completely closed to navigation during the following periods: July 1 to 28 and August 22 to December 31, 1896; January 1 to 13, February 5 to 16, and June 19 to 30, 1897. The local steam ferry and the Yazoo and Big Sunflower packets required a stage of 22.5 feet on the Kleinston gauge to come to the city front. The Greenville, New Orleans, and Natchez packets required a stage of 25 feet, and the Anchor Line steamers came in on a stage of from 28 to 32 feet.

List of steamboats arriving at and departing from Vicksburg during the fiscal year 1897.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Arrivals.	Departures.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
City of New Orleans	Side-wheel.	1,586.28	290	48	8.5	5 6	12 0	13	13	100
City of St. Louis	do	1,614.02	300	49	8.8	5 0	13 0	14	14	150
New South	do	846.55	257	42.6	7	3 0	9 0	9	9	45
Morning Star[a]	do	46.51	95	20.4	2.4	2 2	3 0	21	21	371
Bluff City	Stern-wheel.	584	225	40.5	7	2 6	6 6	7	7	75
Buckeye State	do	669.92	252.3	39.2	6.8	3 0	9 0	9	9	27
John K. Speed	do	1,090.27	261	42	8.6	3 0	9 0	16	16	121
State of Kansas	do	1,130.34	252	52.6	6	3 0	9 0	15	15	99
City of Savannah	do	335.55	186	31	5	3 0	6 0	38	38	1,312
T. P. Leathers	do	509.47	220	40	6.5	3 0	9 0	40	40	300
Pargoud	do	594.50	242	43	7.6	4 0	9 0	20	20	150
Imperial	do	494.69	210	40.6	6.6	3 0	8 0	4	4	30
Annie Laurie	do	199.81	138	27	4.8	3 0	6 0	312	312	1,500
Ruth	do	217.90	160	31.5	5	3 0	7 0	208	208	1,000
Saint Joseph	do	277.13	170	32	4.9	2 0	6 0	156	156	20,000
Rees Pritchard	do	196.20	150.3	31	3.3	1 9	4 0	126	126	204
John F. Allen	do	133.96	130.2	24	4.2	1 8	4 0	7	7	57
Hibernia	do	157.06	135	25	4	2 0	4 0	7	7	42
Atlanta[a]	do	85.03	93	16.4	3.7	1 10	3 6	46	46	468
Novelty[a]	do	63.40	76.4	16.4	3	1 3	3 6	38	38	500
Yazonia[a]	do	62.84	95	19.8	3.5	1 3	3 6	3	3	19
Lake Palmyra	do	141	123.5	26	4.8	2 6	4 6	65	65	325
Mary Joyce[a]	do	34.64	65	14	2.4	1 1	2 0	2	2	10
Water Maiden[a]	do	23.13	69	12	2.6	1 11	2 0	40	40	872
Mildred[a]	do	19.76	54.5	11	3.2	......	......	4	4	......
Mima[a]	do	62.72	66	17	3.2	1 2	2 6	2	2	13
May Flower[a]	do	19.07	64.3	15.6	6.7	......	......	1	1	......
Memphis[a]	do	110.28	111	26	4	......	......	1	1	......
Maggie[a]	do	50.13	85	19	3.5	1 6	3 0	1	1	6
Eugene	do	508.85	170	34	4.4	......	......	2	2	30
Josephine Loviza[b]	do	95	113.6	22.2	3.7	2 4	3 6	4	4	......
Fifteen[a]	do	75	103	18	3.5	1 8	3 0	3	3	29
Mattie M	do	73.45	95	24	2.8	1 8	3 6	1,460	1,460	21,900
L. L. B	do	6.54	36.6	16.7	2.3	1 10	1 10	2	2	......
Will Davis[b]	do	75	100.8	23.6	3.6	1 8	2 2	1	1	......
Electric	do	34.57	77.6	20	2.8	......	......	1	1	......
Belle Prince	do	109.12	114.4	19.6	3.6	1 0	7 0	1	1	200
Henry Marx[b]	do	199.57	138	30	4.5	......	......	2	2	......
Crescent[b]	do	239.96	144	28	5	......	......	2	2	......
Alarm[b]	do	189.09	142	26	4.3	......	......	3	3	......
Thomas A. Hendricks[b]	do	81.86	108	22.5	4.2	4 2	5 0	2	2	......
Resolute[b]	do	207.78	137.6	29	3.9	......	......	1	1	......
John A. Wood[b]	do	687.52	198	40	7	......	......	2	2	......
Raymond Horner[b]	do	688.58	195	45.1	6.7	......	......	2	2	......
Cruiser[b]	do	240.06	152	30	5	......	......	3	3	......
Wash. Honshell[b]	do	134.99	157	28.6	4	......	......	3	3	......
Smoky City[b]	do	549.36	194	35	6	......	......	1	1	......
W. W. Oneal[b]	do	778.96	201	46.2	8	......	......	1	1	......
Exporter[b]	do	578.19	186.5	35	6.1	......	......	1	1	......
Mississippi	do	390.14	174	32	6	......	......	3	3	......
Emma Etheridge	do	188.45	128	26.1	5	......	......	4	4	......
Vedette	do	125.44	118.2	23.8	3.7	......	......	8	8	......
Joseph Henry	Side-wheel.	340	180	32	5.8	......	......	5	5	......
J. N. Macomb	do	300	176.9	62	7	......	......	4	4	......
Golden Gate	Stern-wheel.	142.17	131.4	30	5	......	......	4	4	......
Search	do	149.80	120.5	22.5	4	......	......	4	4	......
Alert	do	159	132.1	24	4.5	......	......	2	2	......
John R. Meigs	do	330	172	38	5	......	......	12	12	......
Thomas B. Florence	do	60	96	20	4	......	......	14	14	......
Columbia	do	75	116	24	3	......	......	......	1	......
Tilda	Tug	30.15	71.6	14	5.6	......	......	1	1	......

[a] With one or more barges.

[b] Towboats.

List of steamboats arriving at and departing from Vicksburg, etc.—Continued.

Name.	Class.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Arrivals.	Departures.	Passengers.
						Light.	Loaded.			
			Feet.	*Feet.*	*Feet.*	*Ft. In.*	*Ft. In.*			
General Comstock	Tug	57	76	16	7	......	......	1	1	......
J. B. O'Brien [a]	do	44.49	70.8	15.2	7	7 0	9 0	6	6	......
Joe Seay	do	27.74	75	16	6	7 0	8 0	Harbor tug.		......
Laurel	do	20.70	60	14	6	......	......	1	1	......
Joe [a]	do	18.07	44.5	10	4	5 6	5 9	1	1	......
Claribel	do	26.88	64	16	6.3	......	......	1	1	......
Carrie Currens	do	7.03	40.4	11.2	3.4	......	......	1	1	......
Troubadour	Yacht	15.50	74	10	4	......	......	1	1	......
Zanuchi Clarissa	Sloop	......	......	......	......	......	......	1	1	......

[a] With one or more barges.

Summary of commerce reported.

Articles.	1896-97.			1895-96.		
	Yazoo River and tributaries.	Mississippi River.	Total.	Yazoo River and tributaries.	Mississippi River.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	25,913	5,364	31,277	20,193	4,911	25,140
Cotton seed	44,449	17,127	61,576	29,161	13,498	42,659
Coal	....	15,000	15,000	....	15,000	15,000
Lumber	3,924	7,130	11,054	4,487	2,036	6,523
Saw logs	46,200	34,500	80,700	37,000	30,000	67,000
Staves	27,730	730	28,460	63,762	180	63,942
Live stock	696	4,411	5,107	191	240	431
Hides and skins	31	111	142	33	133	166
Grain	7,741	12,790	20,531	7,443	21,325	28,768
Provisions	21,448	21,851	43,299	20,450	15,495	35,945
Miscellaneous	26,725	17,396	44,121	30,225	14,400	44,625
Total	204,857	136,410	341,267	212,945	117,218	330,163
Estimated value	$3,218,000	$4,756,600	$7,974,600	$3,619,000	$4,088,000	$7,707,000

The large return of tonnage of live stock was due principally to the removal of stock from the overflowed lands during the recent high-water period.

The decrease in the grain tonnage was due to the constantly increasing home production of corn and other food stuffs.

The secretary of the Vicksburg Cotton Exchange reports the total receipts of cotton for sale at Vicksburg from all sources for the year ending June 30, 1897, as 30,597 bales.

The Vicksburg cotton-seed oil mills report the total number of sacks of cotton seed received by river for their mills as 594,300 sacks.

Receipts and shipments reported by railroads.

Articles.	1896-97.				1895-96.			
	Alabama and Vicksburg and Vicksburg, Shreveport and Pacific railroads.		Yazoo and Mississippi Valley Railroad.		Alabama and Vicksburg and Vicksburg, Shreveport and Pacific railroads.		Yazoo and Mississippi Valley Railroad.	
	Received.	Shipped.	Received.	Shipped	Received.	Shipped	Received.	Shipped.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	28,195	38,710	6,235	25,900	27,155	10,255	4,770	26,015
Cotton seed	4,341	....	13,120	....	3,171	....	12,414	....
Coal	33,666	32,948	3,330	....	....	26,007	4,520	....
Lumber	4,648	1,413	2,960	7,220	6,428	3,586	2,120	5,450
Staves	....	....	....	....	....	755	1,470	....
Live stock	1,191	197	1,964	780	418	1,163	....	520
Grain	7,877	36	10,900	5,450	3,180	6,225	4,732	2,392
Provisions	77,062	5,469	12,726	6,875	10,771	6,382	8,455	6,205
Miscellaneous	18,495	67,474	41,457	32,666	14,418	77,686	35,341	28,835
Total	175,475	146,247	92,692	78,891	65,486	132,059	73,822	69,417

Receipts and shipments reported by railroad—Continued.

	1896–97.	1895–96.
	Tons.	*Tons.*
Total receipts of railroads	268, 167	139, 308
Total shipments of railroads	225, 138	201, 476

Traffic westward on the Vicksburg, Shreveport and Pacific Railroad was interrupted by water from the Biggs Crevasse (on the Louisiana side of Mississippi River) from March 18 to May 20, 1897. This crevasse took place on the night of March 16, 1897, about 10.30 o'clock. Train service on the Yazoo and Mississippi Valley Railroad north of Vicksburg was partially interrupted by overflow water March 31, and was entirely suspended from April 8 to June 6, 1897.

U 10.

IMPROVEMENT OF TALLAHATCHIE RIVER, MISSISSIPPI.

In the fiscal year 1896 a force equipped with axes, saws, explosives, etc., worked at low stages of the river from the mouth of Coldwater down to Robinson Ferry, 2 miles below Sharkey, removing leaning timber, stumps, snags, logs, jams of drift, etc., obstructing navigation. Foreseeing that the appropriation of 1894 would be exhausted in a few days, a project for expenditure of the funds appropriated for continuing the improvement by river and harbor act of June 3, 1896, was submitted June 12, 1896, with the recommendation that the party take advantage of the favorable conditions and continue operations downstream. As no action had been taken on this project, work was suspended June 24, when the appropriation of 1894 ran out.

July 1, 1896, telegraphic authority was received to continue work under the act of June 3, 1896. By that time the laborers had scattered, and reorganization of the force was not completed until July 6. From that date to September 24, 1896, operations were continued downstream from Robinson Ferry to the head of Yazoo River, about 63 miles, under the supervision of Overseer John Schuh. The river was at an extreme low stage throughout this period, and effective work was accomplished.

From Robinson Ferry to Sturdivant there were not many obstructions in the channel compared with other stretches, but the banks were covered with a heavy growth of leaning timber. From Sturdivant to Glendora the channel was much obstructed by snags, logs, stumps, and by trees which had caved and slid into the river. The stretch from Glendora to Black Bayou, especially at lower end of McMullen Place, was obstructed badly by tree slides, caving banks, heavy leaning timber, and a thick growth of brush. Below Black Bayou to Big Bosom the worst obstructions were in the bends, and around Nine Mile Bend to Pecan Point, a very crooked stretch, steamboats could pass with greatest difficulty on the low stage, on account of snags, logs, etc., in the channel. From Pecan Point around Lone Star Bend to Philipp, the channel was very rough on account of tree slides and caving banks in short bends. Between Philipp and Minter City were two bad bends, obstructed by caved-in and sliding trees, in one of which the steamer *John F. Allen* had sunk twice. From Minter City to Sunnyside the channel was badly obstructed by tree slides in three bends, and thence down to Shellmound snags, logs, stumps, and trees were numerous. From Shellmound to the mouth the worst obstructions encountered were in the short bends and on the bars around Race Track Bend, including some large trees lying across the channel, and by caving and sliding banks below the sunken steamship *Star of the West.*

The work was done as thoroughly as possible with the limited means available. At shallow places care was used to remove all obstructions, to give steamboats full depth on crossings at the low stage, and generally the destruction of snags and logs was followed by immediate scour. As a rule, leaning trees were felled, trimmed, and cut into short lengths, but a great many were topped, where there was no probability of caving or sliding. Trees which sink when green were deadened for future removal, or felled and pulled back from the river. Points were well cleared of timber and brush, to relieve opposite bends where caving. Snags and logs were pulled out and cut up, or destroyed with explosives if too heavy or too deeply embedded to be hauled out. Stumps on points, in bends, and in the channel were destroyed, and those within the banks were chopped or sawed close to the ground. Trees which had caved or slid into deep water were destroyed with dynamite, and those in shallow places were pulled ashore. Shore snags on points or in bends were blown up, and others were cut close to the ground.

The following is a summary of the work done from July 6 to September 24, 1896, viz:

Channel snags pulled, cut, and destroyed	9,328
Stumps pulled, cut, and destroyed	13,103
Shore snags cut, and destroyed	10,578
Logs pulled, cut and destroyed	14,248
Leaning trees cut and destroyed	25,463
Leaning trees topped	1,686
Trees girdled	39,946
Square yards willows and brush cut	2,744
Removed frame upon which beam of wreck of steamship *Star of the West* (sunk 1863) rested.	

New obstructions are brought into the river every year by drift and sliding and caving banks, and the shifting and scouring of the channel exposes snags and logs, embedded in the bottom, from time to time, or lodges them upon bars. An appropriation sufficient to permit the systematic clearing of the banks, in addition to snagging operations, could be expended profitably in one season of low water, would result in lasting benefit to navigation, and but small amounts would be needed for maintenance.

Money statement.

July 1, 1896, balance unexpended	$4,014.16
June 30, 1897, amount expended during fiscal year	3,489.52
July 1, 1897, balance unexpended	524.64
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

The following appropriations have been made:

By act of—		By act of—	
March 3, 1879	$6,000	September 19, 1890	$5,000
June 14, 1880	9,000	July 13, 1892	5,000
March 3, 1881	3,000	August 18, 1894	4,000
August 2, 1882	3,000	June 3, 1896	4,000
July 5, 1884	3,000		
August 5, 1886	3,500	Total	50,500
August 11, 1888	5,000		

COMMERCIAL STATISTICS.

The river was reported navigable to Sharkey the entire fiscal year.

List of stern-wheel steamboats navigating Tallahatchie River in fiscal year 1897.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.				Between.	Round trips.	Passengers.
					Light.		Loaded.				
		Feet.	*Feet.*	*Feet.*	*Ft.*	*In.*	*Ft.*	*In.*			
E. A. Pharr	63.61	90	29.9	4.2	2	2	3	6	Yazoo and Coldwater rivers	30	720
John F. Allen	133.9	130.2	24	4.2	1	8	4	0	Vicksburg and Sharkey	30	289
Hibernia	157.06	135	25	4	2	0	4	0	.....do	1	15
Rees Pritchard	106.2	150.3	31	3.3	1	9	4	0	.....do	10	113
Yazonia *a*	62.84	95	19.8	3.5	1	3	3	6	Greenwood and Sharkey	22	239
Maggie *a*	50.78	85	19	3.5	1	6	3	0	.....do	22	209
Fifteen *a*	75	103	18	3.5	1	8	3	0	.....do	20	197
L. L. B	6.54	36.6	16.7	2.3	1	10	1	10	Vicksburg and Shellmound	1	....
Thomas A. Hendricks *b*	81.86	108	22.5	4.2	4	2	5	0	Vicksburg and Coldwater River.	1	....

a With one or more barges. *b* Towboat.

The following light-draft barges were employed in this trade, viz: *Sunlight*, 150 tons; *Fred Lloyd*, 165 tons; *Life Buoy*, 150 tons, and *Geo. W. Bookout*, 125 tons.

Summary of commerce reported.

Articles.	1896–97.	1895–96.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cotton	2,500	2,840	3,038	4,338	3,141	5,588	4,000
Cotton seed	7,170	6,374	6,940	7,300	4,400	8,257	6,000
Hides and skins	5	4	2	3	3	53	5
Live stock	52	45	46	30	30	31	32
Lumber	910	1,402	1,614	1,400	1,300	1,188	1,424
Staves	3,766	22,217	23,404	14,846	3,447	3,204	9,245
Provisions	4,206	4,200	4,800	4,700	3,450	5,571	4,200
Grain	200	200	6,300	6,100	1,800	5,725	4,800
Saw logs	2,000	4,600	20,000	49,500	26,700	24,478	19,000
Miscellaneous	1,625	1,690	4,800	5,100	4,100	6,829	5,000
Total	22,434	43,572	70,939	92,817	48,371	60,419	53,706
Estimated value	$964,000	$1,167,000	$2,061,000	$2,372,000	$908,000	$2,428,000	$2,115,000

The Yazoo and Mississippi Valley Railroad, operated by the Illinois Central Company, has a branch line from Clarksdale to and across Tallahatchie River at Philipp, which is paralleled by a branch of the Southern Railway from Webb to Ittabena, and the Southern Railway and Illinois Central at Greenwood are competitors for the trade of Tallahatchie River.

U II.

IMPROVEMENT OF BIG SUNFLOWER RIVER, MISSISSIPPI.

The river and harbor act of June 3, 1896, appropriated $5,000 for continuing the improvement of Big Sunflower River, and under my project of June 24, approved July 7, 1896, it was proposed to continue the work by hired labor as heretofore, viz:

> Removing snags, sunken logs, etc., in the channel, cutting leaning timber along the banks, repairing and building inexpensive wing dams of piling and brush cut in clearing the banks, where needed to scour the bars, and closing chutes by the same means. Work to begin at the mouth and extend upstream as far as practicable with the means available, special attention being given to stretches difficult of navigation at low stages.

No work was done during the fiscal year ending June 30, 1897, for lack of plant. The snag boat *Columbia*, the lightest in the district and best adapted for the purpose, was required for use in Ouachita River and could not be spared, and the amount available was too small for construction or hire of a suitable vessel.

Escape water through crevasses along the Mississippi front during the recent flood of Mississippi River is said to have brought a large quantity of drift down the Sunflower, and numerous new obstructions are reported in the lower river. As soon as practicable it is proposed to send a snag boat to remove the worst snags and logs and to reorganize the party equipped with axes, saws, tackle, and explosives for work at low water in Yazoo and Sunflower rivers.

Attention is invited to the following extract from my report of 1891, repeated each year since, viz:

> The estimate of $66,000, made in 1879, for the improvement of this river (p. 984, Report Chief of Engineers, 1879), did not contemplate doing the work at irregular intervals extending over a period of fifteen years, as it will with the usual appropriations, but was made with a view to finishing it in not more than three or four consecutive seasons. As new obstructions are added from time to time it is impossible to make any definite estimate, but if an appropriation of not less than $20,000 is made it can be spent to advantage and with economy in one or two low-water seasons, and result in greater benefit to navigation and work of a more lasting character than a larger sum by small allotments every other year.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
July 1, 1897, balance unexpended	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	20,000.00

The appropriations have been as follows:

By act of—		By act of—	
March 3, 1879	$20,000	September 19, 1890	$5,000
June 14, 1880	8,000	July 13, 1892	5,000
March 3, 1881	4,000	August 18, 1894	5,000
August 2, 1882	5,000	June 3, 1896	5,000
July 5, 1884	5,000	Total	72,000
August 5, 1886	5,000		
August 11, 1888	5,000		

COMMERCIAL STATISTICS.

Big Sunflower River was navigable for light-draft boats to Woodburn the entire year. During high stages, March 1 to May 15, it was navigable to mouth of Hushpuckena Creek.

List of stern-wheel steamboats engaged in navigation during the year.

Name.	Tonnage.	Length.	Breadth.	Depth.	Draft.		Between—	Round trips.	Passengers.
					Light.	Loaded.			
		Feet.	Feet.	Feet.	Ft. in.	Ft. in.			
Lake Palmyra	141	123.5	26	4.8	2 6	4 6	Vicksburg and Woodburn Vicksburg and Lehrton	17 11	....
Mary Joyce *a*	34.64	65	14	2.4	1 1	2 0	Vicksburg and Big Sunflower River.	2	....
Hibernia	157.06	135	25	4	2 0	4 0	Yazoo City and Big Sunflower River.	4	23
Novelty	63.40	76.4	16.4	3	1 6	3 6	Vicksburg and Lehrton	38	500
Water Maiden	23.13	69	12	2.6	1 11	2 0	Vicksburg and Rolling Fork	3	10
Morning Star	46.51	95	20.4	2.4	2 2	3 0	Vicksburg and Big Sunflower River.	1	....
Maggie	50.73	85	19	3.5	1 8	3 0	Yazoo City and Big Sunflower River.	27	197
Josephine Lovisa *b*	95	113.6	22.2	3.7	2 4	3 6	Vicksburg and Callao	1	....
Yazonia	62.84	95	19.8	3.5	1 3	3 6	Yazoo City and Big Sunflower River.	30	240
Fifteen	75	108	18	3.5	1 8	3 0	.....do	66	462
Ferd R *a*	45.5	93	16	3	1 1	3 0	Yazoo City and Campbellsville.	52	....
Mima *a*	62.72	66	17	3.2	1 6	1 6	Vicksburg and Lehrton Vicksburg and lower river	2 2	....
Alarm *b*	189.09	142	26	4.8	......	......	Vicksburg and Big Sunflower River.	1	....
May Flower	19.07	64.3	15.6	6.7	......	......	.....do	1	....
Mildred	19.76	54.5	11	3.2	......	......	.....do	2	....

a With one or more barges. *b* Towboat.

Summary of commerce reported.

Articles.	1896–97.	1895–96.	1894–95.	1893–94.	1892–93.	1891–92.	1890–91.	1889–90.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Cotton	2,250	2,050	3,601	2,400	2,699	4,118	2,375	2,594
Cotton seed	5,132	5,407	5,760	5,700	5,250	5,450	3,500	3,975
Hides	14	17	24	12	19	12	....	....
Live stock	524	80	71	38	250	265	70	150
Saw logs	4,000	1,200	2,475	5,650	19,000	21,835	15,400	4,000
Lumber	564	557	1,500	780	1,130	906	920	869
Staves	9,700	17,805	8,105	9,405	9,840	4,430	3,219	5,250
Miscellaneous	9,700	9,372	375	2.050	1,088	2,549	2,027	....
Total down freight	31,884	36,488	21,911	26,035	39,276	39,565	27,511	16,838
Return freight	3,228	2,380	2,623	4,285	4,023	7,489	4,473	5,322
Total	35,112	38,868	24,534	30,320	43,299	47,054	31,984	22,160
Estimated value	$702,000	$783,000	$956,000	$988,000	$893,000	$1,354,000	$945,000	$1,240,000

The Yazoo and Mississippi Valley Railroad crosses the river at Clarksdale and thence runs south parallel to the stream at distances varying from 5 to 20 miles. The Georgia Pacific (Sixth) Division of the Southern Railway crosses the river at Baird with a line running from Greenville, on the Mississippi River, to Atlanta, Ga.

U 12.

WATER GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

The present service consists of twenty two gauges, at which observations at 8 a. m. and 4 p. m. daily were continued during the fiscal year ending June 30, 1897, viz: On Mississippi River, at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., mouth of the White River, Ark., Lake Providence, La., Vicksburg, Miss., Natchez, Miss., Red River Landing, La., Baton Rouge, La., Donaldsonville, La., and Carrollton (New Orleans), La.; on Ohio River, at Louisville, Ky., head and foot of falls; on Tennessee River, at Florence, Ala.; on Cumberland

River, at Nashville, Tenn.; on White River, at Jacksonport, Ark.; on Arkansas River, at Little Rock, Ark.; and on Red River, at Alexandria and Shreveport, La., and Garland and Fulton, Ark.

Records of the daily readings were furnished the secretary of the Mississippi River Commission; copy of the Florence record was furnished the engineer officer in charge of Tennessee River; copy of the Carrollton record was sent the assistant engineer at South Pass of the Mississippi; copy of the Jacksonport record was sent the chief engineer of the Mississippi Levee Commissioners; and district officers, levee commissioners, etc., were furnished copies of records upon application.

The following gauges were inspected during the year by Asst. Engineer John Ewens, viz:

Date.	Gauge station.	Repairs made, etc.
1896.		
Oct. 9	Vicksburg, Miss	Vertical gauge on piling of railway incline at Kleinston Landing rebuilt from —8 to 50 feet, in 3 sections, viz, —8 to 17, 16.5 to 39, and 38.5 to 50.
13	Lake Providence, La	Vertical gauge rebuilt from —7 to 39 feet, in 7 sections, viz, —7 to 3, 2 to 7, 6 to 13, 12 to 18.5, 17 to 26, 25 to 33, and 31 to 39. New bulletin needed.
16	Mouth White River, Ark	Vertical gauge rebuilt from 9 to 44 feet, in 5 sections, viz, 9 to 19, 14 to 23, 23 to 30, 30 to 37, and 37 to 44. Bulletin moved downstream ⅜ mile. New bulletin needed.
19	Helena, Ark	Vertical gauge moved from elevator rebuilt on piling of railway incline from —3 to 51.4 feet, in 6 sections, viz, —3 to 12, 5 to 20, 18.5 to 29, 25 to 38.4, 38 to 43.5, and 42 to 51.4. Bulletin moved from elevator to old bulkhead about 500 feet above. New bulletin needed.
21	Little Rock, Ark	Vertical gauge on Baring Cross Bridge rebuilt from —2.3 to 19 feet, in 2 continuous sections, viz, —2.3 to 4.5, and 4.5 to 19.
23	Jacksonport, Ark	Vertical gauge rebuilt from —2 to 4, 2 to 9, 8 to 13, 13 to 18.9, 18 to 26.5, and 26 to 36.
26	Memphis, Tenn	Vertical gauge moved from elevator to foot of Beale street, about ⅜ mile below, and rebuilt from —5 to 38 feet, in 8 sections, viz, —5 to 4, 3 to 9, 6 to 12, 11 to 15.8, 15 to 20.5, 19 to 24, 22.3 to 28, and 28 to 38.
28	Florence, Ala	Vertical gauge on Memphis and Charleston Railroad bridge rebuilt in one section from —2 to 32.5.
29	Nashville, Tenn	Deposit of débris from 40 to 46 foot mark of inclined section on levee at foot of Broad street, ranging from ½ to 2 feet deep, removed, and gauge marks recut, to be legible.
31	Louisville, Ky. (upper)	Vertical gauge at head of Louisville and Portland Canal cleaned, and graduations and numbers repainted.
31	Louisville, Ky. (lower)	Both sections of vertical gauge at foot of Louisville and Portland Canal cleaned, and graduations and numbers repainted.
Nov. 5	St. Louis, Mo	Vertical section from 31 to 37 feet rebuilt.
9	Cairo, Ill	Deposit of cinders, mud, etc., removed from lower part of inclined section.
13	Natchez, Miss	Vertical gauge rebuilt from —2 to 50 feet, in 2 sections, viz, —2 to 12 and 10 to 50. New bulletin needed.
16	Red River Landing, La	Vertical gauge rebuilt from —3 to 45 feet, in 6 sections, viz, —3 to 9, 7.5 to 15, 15 to 23, 23 to 31, 31 to 38, and 36 to 45.
18	Baton Rouge, La	Vertical gauge rebuilt from —1 to 36 feet, in 7 sections, viz, —1 to 5, 0 to 8, 7 to 12, 12 to 17.9, 17.8 to 24, 24 to 30, and 30 to 36.
20	Donaldsonville, La	Lower part of section 1 cleaned.
23	Carrollton, La	Vertical gauge rebuilt from —2 to 20 feet, in 3 sections, viz, —2 to 6, 3 to 12.4, and 12 to 20.
25	Alexandria, La	Vertical gauge rebuilt from —5 to 39 feet in 7 sections, viz, —5 to 0.2, —1 to 4, 3 to 9.3, 8 to 15, 14 to 20.8, 20 to 28.5, and 27.5 to 39.
27	Shreveport, La	Lower section of vertical gauge on railroad bridge rebuilt from —7 to 0, and all sections cleaned of deposit.
Dec. 1	Fulton, Ark	Gauge intact and in good order, so far as visible.
2	Garland, Ark	Vertical gauge on railway bridge rebuilt from 7 to 32 feet, in 2 sections, viz, 7 to 14.4, and 14.4 to 32.
1897.		
Mar. 25	Vicksburg, Miss	Section for vertical gauge on piling of railway incline at Kleinston Landing built from 46 to 54 feet.
26	do	Vertical section built in elevator building from 46 to 54 feet.
30	do	Vertical section built at foot of South street from 49.2 to 54 feet.
Apr. 23	do	Vertical gauge at elevator. No repairs made.
May 18	Natchez, Miss	Section of vertical gauge rebuilt from 44.5 to 50 feet.
19	Vicksburg, Miss	Section of vertical gauge at elevator rebuilt from 42 to 51 feet.
26	do	To determine difference, if any, between gauges at elevator and Kleinston Landing.

Gauge readings are forwarded to this office by observers at the close of each week, where they are reviewed and filed. Small bound books containing the original records noted at the gauges are filed at this office by the observers at the close of each calendar year. Copies of the gauge readings are sent the secretary of the Mississippi River Commission each week, and they have been published by that body in pamphlet form, with those of other gauges on the Mississippi River and its tributaries, to end of the calendar year 1896.

Gauge staves are prepared in advance at Vicksburg and shipped where needed, a few sections being kept on hand at stations with caving banks or where the gauge must be set in an exposed place. They are of two sizes, the larger (2 by 10 inches) being bolted to bridges, wharves, etc., where there is any degree of permanence, and the smaller (2 by 5 inches) are spiked to piling or driven into the bank and braced as securely as possible at successive elevations. White pine or cypress posts are used and the numbers and graduations in feet and tenths are branded in them, saving time and money, giving uniform scales, and marks not easily obliterated. Painted gauges are soon effaced, and the old way of marking graduations with lines of tacks was tedious and expensive. Under the necessity for a quick and cheap means of marking the large number of staves used the present method of branding graduations through iron stencils and numerals with copper dies was devised some years ago.

The Engineer gauges are used by the Weather Bureau at St. Louis, Mo., Cairo, Ill., Memphis, Tenn., Helena, Ark., Vicksburg, Miss., Donaldsonville, La., Florence, Ala., Nashville, Tenn., Alexandria, La., Shreveport, La., and Fulton, Ark., also at Natchez, Miss., Red River Landing, La., and Carrollton, La., during flood stages.

The laws relating to the water gauges on the Lower Mississippi and its tributaries are as follows: Their establishment and maintenance were directed by joint resolution of Congress, approved February 21, 1871 (sec. 5252, Rev. Stats.), viz:

> SEC. 5252. The Secretary of War is hereby authorized and directed to have water gauges established and daily observations made of the rise and fall of the Lower Mississippi River and its chief tributaries at or in the vicinity of St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburg, Red River Landing, Baton Rouge, and Carrollton, on the Mississippi, between the mouth of the Missouri and the Gulf of Mexico; and at or in the vicinity of Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White River; Little Rock, on the Arkansas, and Alexandria, on the Red River, and at such other places as the Secretary of War may deem advisable. The expenditure for the same shall be made from the appropriation for the improvement of rivers and harbors, but the annual cost of the observations shall not exceed the sum of five thousand dollars.

The river and harbor act of August 11, 1888, provided a permanent indefinite appropriation for the purpose of securing uninterrupted gauging, as follows:

> SEC. 6. That for the purpose of securing the uninterrupted gauging of the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of the twenty-first of February, eighteen hundred and seventy-one, upon the application of the Chief of Engineers, the Secretary of War is hereby authorized to draw his warrant or requisition from time to time upon the Secretary of the Treasury for such sums as may be necessary to do such work, not to exceed in the aggregate for each year the amount appropriated in this act for such purpose: *Provided, however,* That an itemized statement of said expenses shall accompany the Annual Report of the Chief of Engineers.

The amount appropriated in the act of August 11, 1888, was—

> For gauging the waters of the Lower Mississippi River and its tributaries, as provided for in joint resolution of twenty-first of February, eighteen hundred and seventy-one, nine thousand six hundred dollars: *Provided,* That three thousand six hundred dollars of same is authorized to be expended in paying the expenses of gauging the said waters during the fiscal year ending June thirtieth, eighteen hundred and eighty-eight.

The same act, in the item of appropriation for continuing operations upon the reservoirs at the head waters of the Mississippi River, provided as follows:

> And the Secretary of War shall cause such gaugings to be made at or near St. Paul during the annual operation of said reservoirs as shall determine accurately the discharge at that point, the cost of same to be paid out of the annual appropriation for gauging the waters of the Mississippi River and its tributaries.

It was evident from the beginning that the appropriation of $5,000 a year was not sufficient to cover the expenses of observations, repairs, and frequent inspection essential to accuracy. In 1872 Major Merrill, who established the original gauges, recommended that the appropriation be increased to $11,000 for extending the service in accordance with the joint resolution of 1871, and in 1873 he recommended $6,000 as necessary for maintenance of the original gauges. (Reports Chief of Engineers, 1872, p. 435, and 1873, p. 523.)

After the appropriations for rivers and harbors became biennial, various expedients had to be resorted to to maintain the service enjoined by the joint resolution of 1871. In 1878 payments for observations stopped for lack of funds, but a number of observers kept up the records without compensation. In 1884 a deficiency appropriation was made for their continuance. In 1886 the Mississippi River Commission paid the observers, and inspected and repaired the gauges on the Mississippi River to prevent the loss of continuous records. In 1887–88 the available funds were exhausted, and readings were continued voluntarily by the observers.

For these reasons section 6 was put in the river and harbor act of 1888.

With an accumulated deficiency of $17,900 from 1871 to 1888 (under intended appropriations of $5,000 a year), the service had deteriorated greatly. Nearly all the gauges had to be rebuilt, and the bulletins on the Mississippi River needed extensive repairs.

The full amount authorized by section 6 of the act of 1888, $9,600 per annum, was allotted by the Chief of Engineers for gauges under this office, and for discharge measurements at St. Paul, Minn., for the fiscal years 1889, 1890, and 1891. In 1889 and 1890 the gauges were rebuilt and kept in good condition; larger bulletins were purchased and erected along the Mississippi; the old bulletins were repaired and painted and used in extending the service to the tributaries, and four new gauges were established, increasing the cost for observations alone by the sum of $540 per annum, with additional charges for inspections and repairs. The payments made during the fiscal year 1889 were $2,834.17 for the preceding year, and $4,310.18 for 1889, a total of $7,144.35, and the total expenses of 1890 amounted to $7,723.53.

* * * * * * *

Notwithstanding the above, I was notified at the close of August, 1896, that the Comptroller of the Treasury now designates allotments under section 6 of the act of August 11, 1888, as fiscal-year appropriations, and that any unexpended balances at the close of each fiscal year, against which there are no outstanding liabilities, should be deposited.

Under existing decisions a fiscal year appropriation of not to exceed $6,000 is provided, of which 8⅓ per cent is allotted for discharge measurements at St. Paul, Minn., leaving but $5,500 a year for the gauges under this office, the cost of which was given at $6,000 in the report of 1887, exclusive of the four gauges added since 1888.

This amount is not sufficient for the purpose. The value of the records depends upon accurate observations and precise elevations of the gauges, which should be checked frequently by levels to established benches. The instability of river banks at the majority of the stations requires that an assistant, with level, rod, and appliances for minor repairs, should visit and inspect them at frequent intervals, and also without delay whenever observers report accidents to the gauges by steamboats, barges, or other causes, or whenever there is reason to believe that the gauge staves have shifted or been moved by the effect of caving and sliding banks. Furthermore, the conditions each year are not the same. Just now nearly all the gauges need rebuilding, all the bulletins require repairs and painting, and those on the main river are worn out and should be replaced with a more permanent kind. One year's expenses, therefore, may be double that of the succeeding year.

* * * * * * *

As the work at St. Paul, Minn., consists of discharge measurements during operation of the reservoirs at headquarters of the Mississippi, a different class of work, under another officer, and without connection with the gauges on the lower river and its tributaries, it is recommended that it be provided for by separate appropriation.

A number of the large bulletins erected in 1890 along the Lower Mississippi are worn out, and all twelve should be replaced as soon as possible. The rapid deterioration of wooden frames from constant exposure to the elements, frequent changes of location when near caving banks, and continual wear and tear of shifting the heavy iron plates in their grooves twice a day uses up the present form of bulletin in five to six years. With a view to improving this branch of the service, plans have been prepared for frames of wrought-iron pipe, the first cost of which will be considerably greater than those made of wood, but their durability will make them cheapest in the end. The present iron plates, $\frac{1}{16}$ by 40 by 46 inches, are too heavy, on account of wear in fitting them in the grooves, especially if warped or expanded, and the difficulty and risk of changing them in a strong wind. Aluminum at present is too expensive, and it is doubtful if paper fiber of sufficient rigidity without bulk of thickness can be had. So far as determined, the best style of plate appears to be one of wire mesh mounted on round iron frames, with numbers and characters riveted or otherwise fastened to the wire. This would necessitate double the number of plates now used, which are lettered on both sides, but will give least resistance to wind pressure.

The estimated cost of twelve bulletins is $2,700, and the charges for transportation and erection probably will increase the amount to $3,000 at least. If a simpler form of plate can be devised, this estimate may be reduced $500 to $600.

The posting of bulletins at a number of stations will have to cease soon until they are replaced.

Money statement.

July 1, 1896, amount available	$5,500
June 30, 1897, amount expended during fiscal year	5,000
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	9,600

My last report gave the amount available July 1, 1896, as $5,645.83, but under decision of Comptroller of the Treasury that it is a fiscal-year appropriation, the unexpended balance from the preceding year has been deducted in the above statement.

Itemized statement of expenditures during the fiscal year ending June 30, 1897, submitted in compliance with requirements of section 6 of river and harbor act of 1888.

Observations:		
Pay of 21 permanent gauge keepers from July 1, 1896, to June 30, 1897, inclusive		$3,720.00
Inspections and repairs:		
Pay of assistant engineer, one month at $150, and five months and three days, at $175 per month	$1,042.50	
Traveling expenses of assistant engineer while inspecting gauges	231.53	
Pay of employees hired to assist gauge inspector and to repair gauges and bulletins	44.10	
Material for repair of gauges	138.19	
Transportation of material for repair of gauges	12.94	
Repairs of gauge bulletin at St. Louis, Mo	27.75	
Leather instrument case for gauge inspector	10.00	
Charcoal for heating brands for marking gauges	2.50	
		1,509.51
Office expenses and contingencies:		
Pay of clerk, eleven days, at $140 per month	51.33	
Pay of clerk, two months, at $100 per month	200.00	
Shelving for filing records	7.00	
Telegrams	1.97	
Telephone hire	10.19	
		270 49
Total		5,500.00

The appropriations and allotments for this work have been as follows:

Allotments from general appropriations for examinations, surveys, and contingencies of rivers and harbors by acts of—	
March 3, 1871	$5,000
June 10, 1872	5,000
March 3, 1873	5,000
June 23, 1874	5,000
March 3, 1875	5,000
Specific appropriations by river and harbor acts of—	
August 14, 1876	5,000
June 18, 1878	5,000
March 3, 1879	5,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	5,000
Deficiency act of March 12, 1884	2,100
Specific appropriations by river and harbor acts of—	
July 5, 1884	5,000
August 5, 1886	5,000
Allotted from specific appropriation by river and harbor act of August 11, 1888	8,700
Deficiency act of October 19, 1888	3,600

Allotments from permanent appropriation made by section 6 of river and harbor act of August 11, 1888, for fiscal years, viz:

1890	$9,000
1891	8,700
1892	5,100
1893	5,500
1894	5,500
1895	5,500
1896	5,500
1897	5,500
Total	129,700

The following statement shows the disposition of the funds apportioned to this work:

Amount expended to June 30, 1897	$119,587.88
Amount of deficiency appropriation of October 19, 1888, not used	3,600.00
Balance of appropriation by act of August 11, 1888, not expended	1,566.29
Balance of allotment for fiscal year 1890, not expended	1,281.66
Portion of allotment for fiscal year 1891 withheld at United States Treasury under ruling that only $6,000 can be drawn each fiscal year	3,518.34
Balance of allotment for fiscal year 1896, not expended	145.83
Total, as above	129,700.00

Comparison of highest water of fiscal year 1897 with highest previously recorded since establishment of present gauges.

Gauge stations.	Year gauge was established.	Elevation of gauge zero above Cairo datum plane.	Elevation of gauge zero above mean Gulf level at Biloxi, Miss. [a]	Highest water previously recorded on present gauge.		Highest water during fiscal year ending June 30, 1897.		Relation to previous highest record.	
				Date.	Gauge reading.	Date.	Gauge reading.	Above.	Below.
		Feet.	*Feet.*		*Feet.*		*Feet.*	*Feet.*	*Feet.*
St. Louis, Mo	1871	400.23	378.97	May 19, 1892	35.95	May 2	30.95		5
Cairo, Ill	1871	290.84	269.58	Feb. 27, 1883	52.17	Mar. 25, 26	51.62		.55
Memphis, Tenn	1871	203.97	182.71	Mar. 23, 24, Apr. 4, 5, 1890.	35.60	Mar. 20	37.68	2.08	
Helena, Ark	1871	161.98	140.72	Apr. 30, 1886	48.10	Apr. 4	51.75	3.65	
Mouth White River, Ark.	1871	128.73	107.47	Mar. 31, 1890	50.40	Mar. 29	52.42	2.02	
Lake Providence, La.	1871	89.62	68.36	June 2, 1892	41.90	Mar. 30	44.40	2.50	
Vicksburg, Miss	1871	66.04	44.78	Apr. 24, 25, 1890	49.05	Apr. 16	52.45	3.40	
Natchez, Miss	1871	36.89	15.63	Apr. 23, 1890	48.60	May 1, 2, 6.	49.83	1.23	
Red River Landing, La.	1871	23.85	2.59	June 27, 1892	48.87	May 14, 15.	50.20	1.33	
Baton Rouge, La	1871	20.06	— 1.20	June 28, 1892	38.45	May 13-15.	40.65	2.20	
Donaldsville, La	1890	b19.14	—b2.12	June 23, 1893	30.60	May 13	32.85	2.25	
Carrollton, La	1872	20.91	— 0.35	June 22, 1893	17.45	do	19.10	1.65	
Louisville, Ky. (upper).	1871	b419.76	b398.50	Feb. 16, 1884	46.60	Feb. 28	35.30		11.30
Louisville, Ky. (lower).	1871	b392.85	b371.59	do	72	do	61		11
Florence, Ala	1871	b418.03	b396.77	Jan. 22, 1882	29.60	Mar. 19	32.50	2.90	
Nashville, Tenn	1873			do	55.30	Mar. 20	49.25		6.05
Jacksonport, Ark	1871			Mar. 14, 1890	33.35	Jan. 7	28.85		4.50
Little Rock, Ark	1871	241.50	220.24	May 21, 1892	31.20	Jan. 21	23.20		8
Alexandria, La	1871	64.46	43.20	June 12, 13, 1892	38.25	Apr. 14, 15.	26.25		12
Shreveport, La	1890	161.27	140.01	May 28, 1892	35.70	Apr. 11-13.	24.10		11.60
Garland, Ark	1890	223.44	202.18	Mar. 24, 1894	28.50	Mar. 24	27.57		.93
Fulton, Ark	1890	244.78	223.52	May 23, 24, 1892	34.85	Mar. 23	28.60		6.25

[a] Mississippi River Commission preliminary value, 21.26 feet above Cairo datum plane.
[b] Preliminary value.

Comparison of lowest water of fiscal year 1897 with lowest previously recorded since establishment of present gauges.

Gauge stations.	Year gauge was established.	Lowest water previously recorded on present gauge.		Lowest water during fiscal year ending June 30, 1897.		Relation to previous lowest record.	
		Date.	Gauge reading.	Date.	Gauge reading.	Above.	Below.
			Feet.		*Feet.*	*Feet.*	*Feet.*
St. Louis, Mo	1871	Jan. 13, 1895	—0.80	Dec. 11	3.80	4.60	......
Cairo, Ill	1871	Dec. 24, 1871	—1	Sept. 16	5.58	6.58	......
Memphis, Tenn	1871	Nov. 6–9, 1895	—2.65	Sept. 19, 20	1.80	4.45	......
Helena, Ark	1871	Nov. 8–9, 1895	—3	Sept. 21	4	7	......
Mouth White River, Ark.	1871	Dec. 23, 1872	0	Sept. 22–25	7.90	7.90	......
Lake Providence, La.	1871	Nov. 17, 1895	—5.30	Sept. 23–26	.53	5.83	......
Vicksburg, Miss	1871	Nov. 13, 14, 1895	—6.53	Sept. 25	1.30	7.83	......
Natchez, Miss	1871	Nov. 13–15, 1895	— .85	Sept. 26, 27	4.65	5.50	......
Red River Landing, La.	1871	Nov. 14, 1895	— .60	Sept. 25 and 29	3.77	4.37	......
Baton Rouge, La	1871	Nov. 14, 1894	.45	Oct. 2	2.70	2.25	......
Donaldsonville, La	1890	Nov. 11, 1894	1	Oct. 3, 4	2.93	1.93	......
Carrollton, La	1872	Dec. 27, 1872	—1.60	Oct. 9–11	.75	2.35	......
Louisville, Ky. (upper).	1871	Nov. 14–16, 1895 Sept. 10–14, 18–22, 1881.	1.70	Sept. 11–13	3.30	1.60	......
Louisville, Ky. (lower).	1871	Oct. 17, 18, 1872	1.60	Sept. 26–28	4.80	3.20	......
Florence, Ala	1871	Sept. 18, 1878	— .76	Oct. 28–Nov. 3	.10	.86	......
Nashville, Tenn	1873	Oct. 15, 16, 1878	— .40	Sept. 27	.65	1.05	......
Jacksonport, Ark	1871	Dec. 24, 1872	—1.10	Oct. 20–22	.20	1.30	......
Little Rock, Ark	1871	Oct. 23, 24, 1879	—1	Oct. 19, 22–24, 27, 28	3.70	4.70	......
Alexandria, La	1871	Sept. 29, 1881	—3.70	Sept. 24, 25, Oct. 20	—3.30	.40	......
Shreveport, La	1890	Dec. 2–4, 1894	—5.50	Oct. 16–20	—3.40	2.10	......
Garland, Ark	1890	Nov. 30–Dec. 2, 1894.	1.10	Sept. 22–25	— .20	....	1.30
Fulton, Ark	1890	June 20–30, 1896	1.40	Sept. 19–25 Oct. 20–22	.10	....	1.30

U 13.

PRELIMINARY EXAMINATION OF COLDWATER RIVER, MISSISSIPPI.

[Printed in House Doc. No. 121, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of August 15, 1896, by Maj. J. H. Willard, Corps of Engineers, of the results of a preliminary examination of Coldwater River, Mississippi, made to comply with provisions of the river and harbor act of June 3, 1896.

It is the opinion of Major Willard, concurred in by the division engineer, Col. J. W. Barlow, Corps of Engineers, and by me, that this river is at present not worthy of improvement by the United States.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. J. H. WILLARD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Vicksburg, Miss., August 15, 1896.

GENERAL: In compliance with instructions contained in your letters of June 15 and August 11, 1896, I have the honor to submit the following report respecting Coldwater River, Mississippi, a preliminary examination of which was directed by section 8 of river and harbor act of June 3, 1896.

Coldwater River has its source in Marshall County, northwestern Mississippi; flows in a southwesterly direction, forming the boundary between De Soto and Tate counties; thence follows an irregular course, in a general southerly direction, through Tunica and Quitman counties to its confluence with the Little Tallahatchie at the head of the main Tallahatchie River.

An examination of the stream was directed by section 2 of the river and harbor act of June 18, 1878, which also called for an estimate of cost of improvement, and to comply with these requirements Captain Benyaurd, under date of January 2, 1879, reported on this and other tributaries to the Yazoo system, the portion referring to Coldwater River being as follows:

> The Upper Coldwater—that is, above the junction of the Yazoo Pass—is not navigated, as the commerce of the country is more economically accommodated by wagon transportation to the Mississippi River on the west and by the Mississippi and Tennessee Railroad on the east. From its junction with the Yazoo Pass it flows through Tunica County, when it joins the Tallahatchie. This distance is about 80 miles. There are no special natural obstructions to be noted, those that abound in the stream being the numerous snags, logs, and overhanging trees which extend throughout its entire length, and the improvement necessary would constitute their removal. For this purpose it would be necessary to have a flatboat fitted out, such as was recommended for the Upper Big Sunflower, and to commence work at the upper limit, say Yazoo Pass, and work downstream, cutting the leaning timber and removing the snags and logs that constitute the obstructions. The cost of this improvement I estimate at $25,000. (Report Chief of Engineers, 1879, p. 985.)

On account of the prevalence of yellow fever throughout the greater part of this district during the summer and fall of 1878, it was impracticable to get full information, and in 1880 Major Benyaurd caused a second examination to be made, the report of which was as follows:

> UNITED STATES ENGINEER OFFICE,
> *Memphis, Tenn., June 19, 1880.*
>
> MAJOR: In accordance with your instructions, I have made an examination of Coldwater and Tallahatchie rivers, running through the counties of De Soto, Tunica, Coahoma, Tallahatchie, and La Flore, in the State of Mississippi, and respectfully submit the following report:
>
> I commenced the examination of Coldwater about 30 miles below Memphis, Tenn., proceeding down the river in a skiff pulled by two skiffmen. For the first 60 miles, to Prattsville, the river was at a low stage, narrow and crooked, and we met a great number of jams extending across the river, over which we had to drag our skiff. Near Prattsville we encountered a solid jam about one-fourth of a mile long, and on walking down the bank of the river for about 5 miles I found several similar jams, resembling those on Red River above Shreveport before their removal. On making inquiries I was informed the jams extended for a considerable distance down the river and that they had been in for a number of years. In order to get below them I had the skiff hauled by wagon to Hudsons Ferry, a distance of 17 miles by land and about 50 miles by water. From Hudsons Ferry upward I found the river entirely unsuitable for navigable purposes. Below the ferry the river widened out into a good navigable river for 25 miles, when it became again narrow and crooked for about 5 miles. We found three slight jams, below which we readily passed. Below this point the river was about half-bank full and to the mouth we found a good navigable stage of water.
>
> In passing down the river I only saw one small town on the banks, located about 25 miles above the mouth of the river, named Belen. It contains four stores and

about 50 inhabitants. The navigable portion of Coldwater runs through a thinly settled country, a large portion of the land being covered with heavy cane and timber. Very little business is done on the river, although the lower part is navigable for about six months in the year. I was informed there had been no steamboats on it for many years, with the exception of the U. S. steamer *Florence*, which went up the river 40 miles last year improving the channel. The only water craft used at present on the river consists of ferryboats to cross the stream at various points, one flatboat to carry staves, and at Belen they had one large skiff having a water wheel worked by hand, capable of carrying 25 bales of cotton, and two large dugouts fastened together and capable of carrying 5 bales of cotton. What little business is done on the west bank goes to the Mississippi River and on the east bank to the Mississippi and Tennessee Railroad.

Tallahatchie River is formed by a junction of Coldwater and Little Tallahatchie rivers, in Coahoma County, and runs to its mouth, a distance of about 210 miles, where it empties into the Yazoo River.

From the mouth of Coldwater to Sharkeys Landing on the Tallahatchie, a distance of 100 miles, the river runs through a wild and thinly settled country.

From Sharkeys Landing to the mouth, a distance of 110 miles, the river runs through a well-settled and very rich country, being one of the finest cotton districts in the Southern States. During the cotton season two steamboats run from Vicksburg to Sharkeys Landing every week, but during the summer season this is reduced to one steamboat per week.

For six months in the year the whole of the Big Tallahatchie River, and for 100 miles up the Coldwater, is navigable without any further improvement.

From inquiries made from planters living near the river and from steamboat men running on the Tallahatchie and Yazoo rivers, I am informed it would be no benefit to improve the upper part of Tallahatchie above Sharkeys, nor any portion of Coldwater River, for the business is so small and so readily accessible to the Mississippi River on the west and to the Mississippi and Tennessee Railroad on the east that the business offered on the river would not be sufficient to pay a single steamboat to run; consequently, if no steamboat would run on that part of the two rivers, any improvement made would be useless.

During the last fall the U. S. steamer *Florence* did a large amount of work on Coldwater and Tallahatchie rivers in cutting and removing overhanging trees and deadening timber on the banks. The work done below Sharkeys has given satisfaction to the steamboat men, but the work done above that point they state is of no benefit to them. They request me to respectfully recommend to you that any future work done on the Tallahatchie River should be done below Sharkeys Landing, and that it consist of the removal of snags from the channel by a light-draft snag boat in the low-water season.

I have the honor to remain, very respectfully,

JOSEPH BURNEY.

Maj. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

(Report Chief of Engineers 1880, p. 1322.)

The river and harbor act of 1879 appropriated $7,000 for improving the stream, and the act of 1880 appropriated $4,000 for continuing the work. No benefits to commerce resulted from the expenditures, and in 1881 Major Benyaurd reported as follows:

> No appropriation was asked for last year, and none will be asked for this year, as the nature of the Coldwater is such that boats could not navigate it with safety without the expenditure of a large amount of money, which I do not deem the commerce of the country would warrant at the present time. The upper portion of the river is obstructed for several miles by solid jams from one-fourth to one-half of a mile in length, resembling those on Red River above Shreveport, La., before their removal; and the navigable portion of the stream runs through a thinly settled country, a large portion of the land being covered with heavy cane and timber. (Report Chief of Engineers 1881, p. 1413.)

Subsequent reports contain similar recommendations. No further appropriations were made, and in 1885 the work was dropped from the list of duties of the district.

In his report of January 2, 1879, Captain Benyaurd advocated improvement of the river below Yazoo Pass only, a distance of about 80 miles, stating that the upper river was not navigated, the commerce of the country being more economically accommodated by wagon transportation to Mississippi River on the west, and by the Mississippi and Tennessee (now the Illinois Central) Railroad on the east. In 1884 the Louisville, New Orleans and Texas Railway (now the Yazoo and Mississippi Valley Railroad, operated by the Illinois Central Company), was completed from Memphis to New Orleans, the upper division running about midway between Coldwater and the Mississippi. What is known as the Tallahatchie branch of that road runs from Clarksdale, on Big Sunflower River, southeast to the Tallahatchie, touching the latter stream at Swan Lake, Sturdivant, and Minter City, and crossing it at Philipp. Yazoo Pass, a bayou and lake (Moon Lake), formerly connected the Coldwater with the Mississippi near Delta, Miss., but was closed by a levee in 1871, and since 1878 the entire country drained by the Coldwater has been secured against overflow by the cooperation of the Mississippi River Commission, the State, and the Yazoo and Mississippi Valley Railroad Company, making navigation dependent upon the natural drainage of the stream. The lands of the Yazoo Delta, when cleared, are the most fertile in the Mississippi Valley, and the advent of railroads, the protection against floods, and the productive soil offer great inducements to settlement.

At present there is little steamboat trade in Coldwater River. Towboats and tugs make occasional trips at high stages to bring out barges of staves for export to foreign countries and saw logs for the mills at Vicksburg and other places on the Mississippi, but they are so irregular and uncertain that it is impracticable to procure reliable reports of the business done or estimate the possible benefits to be derived by opening the river to navigation at lower stages.

At the time of making the original report upon Coldwater River, January 2, 1879, Captain Benyaurd also submitted a plan for the improvement of Tallahatchie River from the mouth of Coldwater to head of Yazoo River. This plan contemplated thorough work, in two successive seasons, for the removal of snags, logs, leaning timber, etc., and the destruction of the wreck of the ocean steamship *Star of the West*, sunk by the rebels in 1863 opposite Fort Pemberton, about 8 miles above the mouth. It was understood that, like all works of this nature, even once thoroughly done, it would require appropriations for maintenance from time to time to remove new obstructions brought into the river every year by drift and sliding and caving banks, snags, and logs embedded in the bottom and exposed by the shifting and scouring of the channel, and the rapid growth of timber and brush along the banks.

The river and harbor act of 1879 appropriated $6,000 for beginning work in Tallahatchie River, and each succeeding act has contained small appropriations for its continuance, amounting in all to $50,500. By the terms of the acts, $5,000 of the appropriation of 1880, $2,000 of the appropriation of 1881, and all of the appropriation of 1882, a total sum of $10,000, were required to be expended in what is known as Little Tallahatchie River, above mouth of Coldwater to Batesville, a stretch not recommended for improvement. This work resulted in no benefit, as there was no local traffic in that part of the stream, and the obstructed condition of the river below mouth of Coldwater prevented boats from running, except at the highest stages.

It is understood that the appropriation of $4,000 for Tallahatchie River by act of June 3, 1896, must suffice for two years, and hence the total sum provided for nineteen years' work below mouth of Coldwater is $40,500, or $500 in excess of the estimate of 1879 for two years' work. Before the improvement was undertaken the river was navigable to

Sharkey Landing, about 65 miles above the mouth, for about six months of the year, but the passage of steamboats was difficult and dangerous on account of snags and leaning timber. Above Sharkey to mouth of Coldwater it was next to impossible for boats to run at any stage, the leaning timber along both banks nearly meeting across the stream. Boats now run to Sharkey the year round, and above that landing to Coldwater River at high stages. During the current year effective work was done above Sharkey, so far as the limited means available would permit, and is now in progress below that place, but there is no permanency of improvement.

At present there are only five farms in cultivation between Sharkey and the mouth of Coldwater, but the land is fertile and said to be covered with a fine growth of marketable timber, and thorough work for the improvement of navigation of that stretch of river would be an inducement to settlement. The railroad is at a considerable distance, and the wagon roads so bad that hauling is out of the question during protracted wet weather. The country along Coldwater is more accessible to the railroad and more thickly settled than upper Tallahatchie, there being several small villages on or near the stream below Yazoo Pass. If the improvement of Tallahatchie River were completed thoroughly from the Yazoo to the Coldwater, in accordance with the original plan, it might be advisable to extend work up the latter stream to Yazoo Pass, or perhaps beyond; but, in my opinion, such work at the present time would result in no benefit to commerce or navigation, and would be a useless expenditure. * * *

Very respectfully, your obedient servant,

J. H. WILLARD,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
Washington, D. C., August 26, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

The conclusion of the district engineer that this stream is at present unworthy of improvement is fully concurred in.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

APPENDIX V.

IMPROVEMENT OF ARKANSAS RIVER AND OF CERTAIN RIVERS IN ARKANSAS AND MISSOURI.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **Removing obstructions in Arkansas River, Arkansas and Kansas.**
2. **Arkansas River, Arkansas.**
3. **White River, Arkansas.**
4. **Black River, Arkansas and Missouri.**
5. **Current River, Arkansas and Missouri.**
6. **St. Francis River, Arkansas.**
7. **St. Francis River, Missouri.**

EXAMINATION.

8. **Neosho River, Kansas.**

SURVEYS.

9. **Arkansas River at Little Rock, Vanburen, and Fort Smith, Arkansas.**
10. **Arkansas River at Pinebluff, Arkansas.**
11. **White River, Arkansas.**
12. **Buffalo Fork of White River, Arkansas.**
13. **St. Francis River, Arkansas and Missouri.**

UNITED STATES ENGINEER OFFICE,
Mount Nebo, Ark., July 15, 1897.

GENERAL: I have the honor to forward herewith annual reports for the fiscal year 1897 of the following works of river and harbor improvement under my charge.

* * * * * * *

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

V 1.

REMOVING OBSTRUCTIONS IN ARKANSAS RIVER, ARKANSAS AND KANSAS.

Object.—To remove (otherwise than by permanent works) obstructions to navigation.

Project.—Originally to raise and destroy snags, cut overhanging timber, remove bowlders and reefs by blasting and dredging, and to cut out sand bars by temporary wing dams. The survey of the river with a view to project for permanent improvement was included under this head.

Since appropriations for permanent improvements were made, blasting, dredging, and dams have been omitted from the project under this head, leaving the customary snagging operations only.

OPERATIONS OF PREVIOUS YEARS.

The operations since 1867 are shown on page 1650 of Annual Report for 1896.

PROGRESS OF WORK.

The Arkansas River has in the State of Arkansas about 370 miles of caving banks; most of the bars are built upon and many of the channel crossings are over rock heaps. The caving banks make continual contributions of snags; the wearing away of sand bars brings the older accumulations into the channel, and removing snags from the crossings allows the sand to wash and expose others.

All of these go to make snagging operations a continuous necessity.

The evidence of pilots and masters is that in the permanent reaches of the river the condition has been materially improved; in the shifting channels the relief is only temporary.

In the lower reaches of the Arkansas River its current is checked by the floods of the Mississippi; the snags and logs drifting toward that stream are deposited in the bed of the Arkansas in all conceivable shapes. In the absence of current the snags make no "breaks," consequently the dangers to navigation are greatly increased.

Snagging operations will be necessary as long as there is a caving timbered bank and a shifting channel; they should not be diminished for many years, and could profitably be increased.

OPERATIONS OF THIS FISCAL YEAR.

There were no operations under this appropriation until in June. Prior to this time the snag boats were operated under the appropriation for improving Arkansas River.

The U. S. snag boat *Beauregard*, after making repairs at Pine Bluff, was operated for eleven days in June between Richland and Bickers Bend, 32 miles. One hundred and forty-nine snags were removed, 81 trees cut, and 4 drifts broken up.

PLANT.

The U. S. snag boats *Wichita* and *Beauregard* are the two snag boats owned by this appropriation. Both have wooden hulls and are in bad condition. The *Beauregard* hull was launched in July, 1893, but deteriorated so rapidly that it was necessary last year to rebuild the main deck forward of the capstans. The boat was last inspected by the steam vessel inspection service June 10, 1897, and the local inspectors report many defective places in the hull. The boat also draws about 6 inches more water than when first built.

The present hull of the *Wichita* was built in 1888; in 1895 it was placed on the Memphis dock and extensively repaired. In the summer of 1896 further repairs were made, and when inspected June 11, 1897, was found to be in very bad condition. It is the opinion of the local inspectors that the boat can be used for another year from that date, provided extra precaution be used. The inspectors state that they can not recommend her being used for a longer period. The cabin of this boat was built in 1881; the boilers were also built then. The cabin is not now worth a new hull, and the boilers are not considered safe for a steam pressure over 150 pounds to the square inch.

Taking the present condition of the two boats into consideration, it is safe to say when the snagging season of 1898 arrives the *Wichita* will be unserviceable and the *Beauregard* will have to be placed on a dock.

The repairs needed will be extensive and costly, and when completed the boat will not draw less than 26 inches, which is too great draft for work during extreme low water, when snagging operations are mostly needed. One boat can not keep the navigated portions of the river clear of snags. The defects of all wood hulls for snag boats have been often shown in the earlier reports of the Chief of Engineers, and it is believed to be false economy to build such boats. They do not cost as much as an all-steel hull or a combination hull, but they are soon twisted by the stresses due to snagging, their draft increases rapidly with each year, due to absorption of water by the wood; they decay rapidly on account of the excessive heat in the hold caused by the leakage of steam from the capstan engines and from poor ventilation due to many necessary bulkheads. It is therefore recommended that the *Wichita* be replaced with a new boat having an all-steel hull or a combination hull, and with engines sufficiently large for the boat to be used as a towboat when not engaged at snagging. It is also recommended that an all-steel hull or a combination hull be built for the cabin and machinery of the *Beauregard.*

To procure a new boat and a new hull for the *Beauregard* it is estimated that $38,000 will be required.

Money statement.

July 1, 1896, balance unexpended	$20,686.06
June 30, 1897, amount expended during fiscal year	2,613.47
July 1, 1897, balance unexpended	18,072.59
July 1, 1897, outstanding liabilities	900.00
July 1, 1897, balance available	17,172.59
Amount (estimated) required for work annually	35,000.00
Amount that can be profitably expended for maintenance in fiscal year ending June 30, 1899	35,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Appropriations for operating snag boats on the Arkansas River have been made intermittently since 1832. Many of the early appropriations were combined with those of other rivers without stated distribution of funds. The estimate of expenditures is not given as absolute, but as a close approximation.

July 3, 1832 (less $38 carried to surplus fund)	$14,962.00
March 3, 1835	40,000.00
March 3, 1837	25,000.00
July 7, 1838 (less $1,115.66 carried to surplus fund)	38,884.34
From appropriations 1842–1844 (estimate)	80,000.00
August 30, 1852 (less $269.47 carried to surplus fund)	39,730.53
From appropriations 1866–1878 (disbursements reported by Colonel Suter)	344,831.59
March 3, 1879 (part)	30,000.00
June 14, 1880 (part)	35,000.00
March 3, 1881 (part)	25,000.00
August 2, 1882	35,000.00
July 5, 1884	36,000.00
August 5, 1886	19,875.00
August 11, 1888	25,000.00
September 19, 1890	20,000.00
July 13, 1892	20,000.00
August 17, 1894	20,000.00
June 3, 1896	20,000.00
Total appropriations	869,283.56
Expended to June 30, 1896	848,597.40
Unexpended July 1, 1896	20,686.06

COMMERCE.

The commerce of this stream is reported under the head "Improvement of Arkansas River, Arkansas."

V 2.

IMPROVEMENT OF ARKANSAS RIVER, ARKANSAS.

ORIGINAL CONDITION.

In addition to such obstructions as snags, the channel of this river was for nearly all of its length of a shifting character and was obstructed by sand bars fed by caving banks. In the upper reaches there were some reefs of rock.

ORIGINALLY ADOPTED PROJECTS AND ADDITIONS.

Prior to 1886 works upon this river were special improvements of detached reaches, generally with immediate reference to confining the channel to drawspans of bridges or the water fronts of towns, and to the improvement of some especially difficult crossing.

The project and estimate for the improvement of the whole river was made in three parts: Annual Report Chief of Engineers, 1885, page 1603, for improving Arkansas River from Little Rock to mouth, $2,538,544; Annual Report Chief of Engineers, 1888, page 1386, for improvement between Fort Gibson and Little Rock, at a cost of $1,307,935, and House Ex. Doc. No. 90, Forty-ninth Congress, first session, for improvement between Arkansas City, Kans., and Fort Gibson, $1,696,900. The act of August 11, 1888, adopts a project for improving Arkansas River from Wichita, Kans., to the mouth, mentioning distinctly the plans, which include the estimates from Little Rock to the mouth and from Fort Gibson to Arkansas City, Kans., and by implication approves the estimate for improvement between Little Rock and Fort Gibson. No estimate has ever been made or approved for the improvement of the river between Arkansas City, Kans., and Wichita, Kans.

The estimates for improving the reach from Little Rock to the mouth and from Little Rock to Fort Gibson were based upon an improvement by permeable dikes alone, and by dredging, whereas the act of August 11, 1888, authorizes the application of any of the methods set forth in the projects for the three reaches at such points between Wichita, Kans., and the navigable mouth of the Arkansas River as the Secretary of War may direct.

The application of those approved methods that have been most effective will largely increase the estimate for improving the reaches between Fort Gibson and Little Rock and between Little Rock and the mouth. Under date of August 29, 1896, authority was granted for calling the estimate for completing the project for improving Arkansas River from Wichita, Kans., to the mouth "Indefinite."

PRESENT APPROVED PROJECT.

To remove rock and gravel reefs by blasting and dredging, to contract the channel by dikes or dams, permeable or solid, of such construction as the local conditions require, and to hold the channel so obtained by revetment, where necessary, from Wichita, Kans., to the mouth, the object being to secure a channel not less than 6 feet in depth from Little Rock to Mississippi River, via White River Cut-off, and not less than 2 feet in depth above Little Rock, Ark.

WORK DONE IN PREVIOUS YEARS.

The work done in previous years is shown on pages 1652–1655 of Annual Report for 1896.

OPERATIONS DURING FISCAL YEAR 1897.

SNAGGING OPERATIONS.

The operations of snag boats is not contemplated in the project for the permanent improvement of this river, but the last two river and harbor acts have made provisions for this class of work, payable from this appropriation. The greater portion of this year's operations has been in the lower reaches of the river. The quarter boat *Monterey* was sent to that part of the river to assist the snag boat in clearing of timber the most rapidly caving banks. The tabulation below gives the amount of work and the localities where done.

Abstract of snagging operations.

Month.	Boat.	Between—	Snags removed.	Trees cut.	Drifts removed.
July	Beauregard	Hannaberry Landing and Mulberry	129	18	13
August	Do	Knotts Island and Montonia Bend	186	76	18
Do	Wichita	Little Rock and Devils Bend	61	....	1
September*	Beauregard	Douglas Bend and Dulin Bend	318	537	37
October	Do	Dupree Bend and Burnetts	348	924	22
November	Quarter boat	Goose Bar and Silver Lake	....	2,159	....
Do	Wichita	Little Rock and Lewisburg	89	13	....
Do	Beauregard	White River and Cooks Point	207	124	4
December	Wichita	Eagle Bend and Trundles	200	210	2
Do	Beauregard	Como and Sawmill bends	60	765	4
Do	Quarter boat	Silver Lake and Red Fork	....	6,250	....
January	Beauregard	Irene Bend	....	458	....
Do	Quarter boat	Red Fork and Irene Bend	....	6,345	....
June	Wichita	Little Rock and Trundles	97	....	....
		Total	1,695	17,879	101

* Also removed wreck of steamer *Bracelet*.

OPERATIONS FOR TEMPORARY IMPROVEMENT.

At many of the shoals, more especially below Little Rock, there are several channels, none of which have in them during low stages sufficient water for navigation purposes. These channels are very shifting, and as they lie in reaches of river in which works for permanent improvement have not been commenced authority was obtained to close all but one of the channels at the most troublesome shoals by low dams or spur dikes built of brush and sand bags. The height of these structures was limited to one-half to 1 foot above the stage of water existing when the work was done. Works of this temporary nature were built at Fergus Bar, Swan Lake, Samples, and Silver Lake, all of which are below Pine Bluff.

Fergus Bar.—This was contraction work and was done with colored labor from Pine Bluff. It consisted of two spur dikes from left bar with a total length of 337 feet, of one pole-crib dike of 250 feet, from right bar to which was added 150 feet of training wall, a total of 737 linear feet of work. The two spurs and the training wall were built by laying bunches of loose brush parallel to line of dam and weighting same with sacks filled with sand, base about 5 feet. The water was very shallow where this kind of work could be done. The pole crib was built in about 20-foot sections, 6 feet wide, and as deep as necessary, floated to position, filled with brush, and sunk with sand bags.

Swan Lake.—A dam 300 feet long closing left chute. The dam was built of fascines, 9 inches by 10 feet, of small willows, laid at right angles to line of dam, covered with sacks enough to sink, and other layers of fascines and sand bags were added as was found necessary, according to depth of water and amount of scour. It was found very difficult to lay the foundation mat across chute on account of rapid scour. Colored labor was used.

Samples.—Five hundred linear feet of dam to close right chute. This work was nearly completed, without plant, by colored labor. The water was too swift and deep and the bottom scoured too rapidly to permit the use of fascines as at Swan Lake, so the mat was woven in sections of about 12 by 16 feet, floated into place, and sunk with sand bags. The foundation mat was laid clear across the chute, but the bottom was quicksand and the scour was very rapid. As many as four layers of mat and sacks were necessary to bring dam up to the top of water that was originally but 2 feet deep. As soon as the quarter boat *Monterey* and two barges came the work was quickly completed. Fully one-half the river was in the chute.

Silver Lake.—This work was supposed to close the two right chutes which existed during low water, but it really amounted to an extension of the right-hand bar for 750 feet in nearly the middle of the river, and acted as a training wall for the current, confining the space on the crossing to about 700 feet. Mat was single weave, 20 feet wide. The first 200 feet was woven in the water and the balance from mat boat. No trouble was experienced. The bottom was not quicksand, and did not scour fast in front of mat, although the cross current for the first 450 feet was strong. Only one layer of mat was used.

The brush used at each place was cut from the bars near by.

Exhibit of field expenditures, account of temporary relief.

	Fergus Bar.	Swan Lake.	Samples.	Silver Lake.
Labor and supervision	$353.83	$179.25	$643.37	$499.25
Sacks and twine	163.00	123.00	424.50	232.25
Sundries	43.00	43.07	12.50	
Nails and wire			3.40	3.75
Rope			22.50	
Total	559.83	345.32	1,106.27	735.25

Exhibit of quantities of material used, account of temporary relief.

	Fergus Bar.	Swan Lake.	Samples.	Silver Lake.
Sacks ... number	4,000	3,000	10,500	6,500
Twine ... pounds	20	20	30	50
Brush ... cords	55	40	112	102
Nails ... pounds			20	
Wire ... do			60	125
Rope ... do			250	

OPERATIONS FOR PERMANENT IMPROVEMENT.

Bruce Island.—The dipper dredge, building at Fort Smith at the first of the year was completed and, in tow of the chartered steamer *Wm. Druhe No. 2*, left for Bruce Island August 6, 1896. The river was falling rapidly and the steamer could not pass over the shoals just above Beaver Dam. The dredge machine not having been tested and accepted from the builders before leaving Fort Smith the test was made in the shoals over which the *Druhe* could not pass. During the test the main cable supporting the A frame was broken and was not replaced until October 6, 1896. The dredge then continued digging through the shoals between Beaver Dam and Bruce Island. While working in the shoal at foot of Choctaw Chute the side bracing on the boom was broken. This was repaired by the crew of the dredge, the material required being obtained at Fort Smith, Ark. Not until November 30, 1896, did the dredge arrive at the site of its work, the shoals at head of Choctaw Chute. Here a channel 2,975 feet long, 70 feet wide, and 3 feet deep at low water was dug. This work was completed on March 2, and the dredge, in tow of the United States snag boat *Beauregard*, was taken to Little Rock, Ark. In connection with the dredging done at this locality the dam in Cherokee Chute was rebuilt with riprap stone on brush-mattress foundation. This dam was originally built in fiscal year 1890 for the purpose of closing Cherokee Chute at 6-foot stage or less. It failed after a short while on account of insufficient bank protection at the ends of the dam, a cut 115 feet wide being made around the island end and one 30 feet wide around the other end. The work of rebuilding was begun January 15, 1897. The plant used was cordelled from Fort Smith. The old dam, a pile structure, was filled with brush and stone. The new work across the cuts was of riprap stone on brush mattress 40 feet wide. The shore protections at each end of the dam are revetments extending 100 feet downstream, a mattress 60 feet wide being used at the high-bank end and one 40 feet wide at the island end. The graded banks were covered with a 4 to 6 inch layer of quarry spawls, over which was placed a layer of riprap stone. This layer varied in thickness from 12 inches at low water to 6 inches at top of the work, which at island end was 12-foot stage and at high-bank end was 20-foot stage. The dam is 6 feet wide on top. The side slopes are 1 on 2 and 2 on 3. The height of dam is 6.5-foot stage along the old portion, but the island end is gradually raised to 12-foot stage and the high-bank end is gradually raised to 9-foot stage. The dam was completed on February 23, and the fleet started to Reid's Bend the next day.

Exhibit of field expenditures, rebuilding dam at Bruce Island.

	Cost per unit.	Cost per item.	Total.
Grading bank.			
Labor, grading 225 lineal feet	$0.34	$76.55	$76.55
Brush.			
Cutting and handling, 170 cords	1.017	172.81	
Hauling, 170 cords	.331	56.25	
Weaving mattress	....	46.10	
Filling old dam	....	70.58	
Rope, 150 pounds	.08	12.00	
Wire, 1,000 pounds	.02	20.00	
Total cost, 170 cords in place	2.222	....	377.74
Stone.			
Labor, quarry, 1,580 cubic yards	.445	702.92	
Explosives (per cubic yard of stone)	.042	67.15	
Labor, loading stone onto barges	.143	226.42	
Cordelling and placing stone	.523	828.06	
Quarry privilege	.032	50.00	
Total cost, 1,580 cubic yards of stone in work	1.187	....	1,874.55
Miscellaneous.			
Transfer of plant from and to Fort Smith	....	130.07	
Repairs to plant	....	52.00	
Property purchased	....	116.36	
			298.43
Total cost of dam	....	....	2,627.27

Near Fort Smith.—This was repair work and was confined to placing additional brush mattresses around the outer ends of the two dikes just above the mouth of Poteau River, and in filling a gap in the north end of Suter Dike. The brush was purchased delivered at the work and was placed by hired labor. The stone for Dikes E and F was purchased and placed in the same manner; that for Suter Dike was purchased delivered in the work.

Exhibit of field expenditures repairing dikes near Fort Smith, Ark.

DIKE E.

	Quantities.	Cost per unit.	Cost per item.
Brush……cords..	34	$1.00	$34.00
Poles……do....	1.3	1.50	1.95
Wire……pounds..	100	.025	2.50
Stone……cubic yards..	96	1.00	96.00
Rope……pounds..	200	.08	16.00
Weaving mattress……squares..	50	.478	23.90
Placing stone……cubic yards..	96	.290	27.84
Total……	………	………	202.19

DIKE F.

Brush……cords..	58.5	$1.00	$58.50
Poles……do....	4.5	1.50	6.75
Wire……pounds..	150	.023	3.40
Stone……cubic yards..	185	1.00	185.00
Rope……pounds..	310	.08	24.80
Weaving mattress……squares..	112	.323	36.18
Placing stone……cubic yards..	185	.232	42.92
Total……	………	………	357.55

SUTER DIKE.

Brush……cords..	20	$1.00	$20.00
Poles……do....	2	1.50	3.00
Wire……pounds..	50	.023	1.15
Weaving mattress……squares..	30	.559	16.77
Stone in place……cubic yards..	74.8	1.60	119.68
Stone in place……do....	72	1.19	85.68
Unclassified labor……	………	………	2.40
Total……	………	………	248.68

Fletchers Bend.—The revetment of this bend was not completed between low water and 8-foot stage during fiscal year, 1896. The portion of the bank above low water, protected by mattress alone, held well, and nothing was done this year toward the completion of this revetment. At the foot of the bend two stone dikes on brush mattress foundation have been built this year. The upper dike, K, is 222 feet long, with foundation mattress 60 feet by 263 feet; width of dike on top is 8 feet; elevation at shore end is 7-foot stage; at outer end is 4.3-foot stage. Construction was begun March 1, 1897, and the work was completed June 22, 1897. The lower dike, L, is 490 feet long, with foundation mattress 60 feet by 500 feet; width of dike on top is 10 feet; elevation of shore end is 9-foot stage, and of outer end is 2-foot stage.

Shore protection at end of dike extends from a point 50 feet upstream from the dike to a point 200 feet downstream; the mattress is 40 feet wide, the riprap carried to 18-foot stage. Construction was commenced February 20, 1897, and, excepting the final filling to form of about 200 feet of the outer end, the work was completed.

Reids Bend Revetment.—Six thousand five hundred and ten feet of caving bank protected, bank graded to 15-foot stage, and riprap laid to 15-foot stage, except 3 sections, 168 feet, 208 feet, and 160 feet long, which were graded to 15-foot stage, but riprapped to 12, 10, and 8 foot stages, respectively. The graded portions of bank not covered by riprap are planted with Bermuda grass. The revetment is not continuous. The first or upstream section is 4,085 feet long; the second section, 475 feet below the first section, is 400 feet long; the third section, 140 feet below the second, is 2,025 feet long. Seven thousand two hundred and forty-five linear feet of mattress was woven, 485 feet was lost by breaking of cables during high water. Construction commenced March 3 and work was suspended June 14, until low-water season, when riprapping of bank between low water and 6-foot stage will be completed. The stone was purchased delivered on bank at Ives Point, Scotts Eddy, Natural Steps, and Ross Hollow; the brush and poles delivered on barges at brush fields, 25 to 55 miles below the works, and the piles at the works.

Dikes at foot of Reids Bend.—Construction of three dikes was begun here, Dike M to be permeable pile dike 190 feet long, Dike N to be permeable pile dike 310 feet long, and Dike O to be riprap stone dike 460 feet long. The foundation mattress for all dikes to be 60 feet wide. The shore protection for all to be 200 feet long, beginning 50 feet upstream from dikes. The mattress used in shore protection to be 40 feet wide, the riprap on bank to be carried to 20-foot stage. Dikes M and N to be built with T heads, similar to those built on the upper Missouri River. The T head mattresses are 70 feet wide and 185 feet long, beginning 80 feet above the dikes. The foundation mattress and shore protection for Dikes M and N have been completed; the piles are yet to be driven. Dike O yet needs to complete it a small quantity of stone, which will be placed during low-water season. The elevation of the outer ends of these three dikes is to be 2-foot stage; the elevation of the shore ends to be 4, 6, and 8 foot stage for M, N, and O, respectively. Construction was commenced April 23, and work was suspended June 14.

Head of Rectors Island.—This was repair work, and consisted of raising a depression in Dam I and extending the shore protection at Dike H 250 feet downstream.

Crystal Hill.—One dike of riprap stone, 490 feet long, 8 feet wide on top, elevation at shore end 8 feet, elevation of outer end 3½-foot stage, foundation mattress 76 feet wide and 500 feet long, shore protection mattress 60 feet wide and 250 feet long, with an additional mattress 40 feet wide and 170 feet long, built January 21 to June 30, to replace the dike destroyed during high water of December, 1895.

There was also built one training wall to Dike F. It begins 70 feet back from the end of the dike and extends 1,700 feet downstream, parallel with the current. It is 8 feet wide on top, and of 6.5-foot stage elevation. The foundation mattress varies from 40 to 70 feet in width. The mattress was woven February 17 to March 1. Placing of stone began January 20, but was not completed until June 30.

The brush for these two works was purchased delivered on barges at brush fields below Little Rock. The stone was purchased delivered in the work.

Newtons Bend.—The revetment begun here last fiscal year was extended upstream 1,700 feet. The mattress used was 60 feet wide. The bank was graded and riprap laid to 15-foot stage, excepting between low water and 4½-foot stage, which is to be completed during low-water season. The revetment built last year was completed by placing the necessary riprap stone between 6-foot stage and low water. The brush was purchased delivered on barges at brush fields below Little Rock. The stone was purchased delivered on bank at the work.

At 1,050 and 1,700 feet below the revetment built last year were gumbo points that projected beyond the general bank line of the bend. Off of the upper point 710 cubic yards and off of the lower point 1,125 cubic yards was dredged. The width of dredging on the upper point was 15 feet; on the lower one 35 feet. The depth of dredging in both cases was to 6 feet below low water. The dredge material was placed in shallow water adjacent to the sand bar opposite the site of the work.

At 2,100 to 3,500 feet below this revetment a channel 1,400 feet long, 6 feet deep at low water, was dredged through the gravel and bowlder shoal located here. The first 300 feet was dredged 70 feet wide, the next 600 feet was 35 feet wide, and the last 500 feet was 70 feet wide. The dredged material (7,800 cubic yards) was placed on the slope of the right bank adjacent to the site of the dredging.

Greathouse Bend.—The dikes begun at this place last fiscal year and the downstream extension of the old revetment were completed in November and December. The old revetment was extended upstream 910 feet in May and June. This extension is in four sections. The first section, 300 feet long, connects with the old revetment; the second section, 120 feet long, is 90 feet above the first; the third section, 120 feet long, is 80 feet above the second; the fourth section is also 120 feet long and 80 feet above the third one. The mattresses are 70 feet wide, the bank is graded, and riprap is carried to 15-foot stage.

Dike D, near Little Rock.—This was repair work, and was confined to completing the shore protection begun last fiscal year.

Peach Orchard Bend.—Three thousand six hundred and ten feet of caving bank at point where the Altheimer Branch of the St. Louis Southwestern Railroad was endangered was revetted by the railway company. The plant used belonged to the United States and was loaned the railway company by the honorable Secretary of War. The cost of this work is given me as $11,710.90, or nearly $3.25 per linear foot of bank protected. In the work there were used 1,132 cords of brush, 1,780 poles, 2,570 linear feet of piling, 5,400 pounds of wire, and 6,138 cubic yards of stone.

Pine Bluff.—This is repair work, and consists of rebuilding the shore protection at Dike 2, the upstream dike of the series of stone dikes along the town front of Pine Bluff. The work was commenced June 18, and at the close of the year 800 linear feet of mattress, 120 feet wide, had been woven and weighted, and 342 cubic yards of stone placed in the work.

Exhibit of field expenditures on work begun this year are given below:

Exhibit of field expenditures on Dikes K and L.

	Dike K.			Dike L.[a]		
	Quantities.	Cost per unit.	Cost per item.	Quantities.	Cost per unit.	Cost per item.
Bank graded.						
Labor grading bank ....linear feet..	....	....	....	250	$0.252	$63.01
Mooring piles.						
Piles delivered at work	7	$2.80	$19.60	12	1.60	19.20
Labor driving piles	7	4.038	28.27	12	3.33	40.01
Fuel (estimated)........................	....	....	.70	....	....	1.20
Total cost of piles in place........	7	6.938	48.57	12	5.03	60.41
Mattress.						
Brush purchased on barges .....cords..	78.2	1.00	78.20	191.3	1.00	191.30
Poles purchased on barges....number..	102	.075	7.65	39	.075	2.92
Wire purchased...............pounds..	500	.022	10.80	1,250	.022	27.00
Labor weaving mattress......squares..	157.2	.523	82.19	400	.548	219.05
Towage................................	....	....	92.51	....	....	226.31
Total cost of mattress ..squares..	157.2	1.726	271.35	400	1.666	666.58
Stone.						
Stone purchased, delivered in place, cubic yards........................	898.7	.90	764.73	2,162.8	.90	1,946.52
Supervision, inspection, etc	849.7	.052	44.20	2,162.8	.045	96.20
Total cost of stone in place, cubic yards....................	849.7	.952	808.93	2,162.8	.945	2,042.72
Miscellaneous.						
Repairs to plant, labor, material, etc....	....	....	33.14	....	....	132.56
Property purchased	....	....	5.27	....	....	21.03
Care of property during high water....	....	....	6.45	....	....	25.81
Moving plant............................	....	....	10.29	....	....	41.11
Total miscellaneous	....	....	55.15	....	....	220.51
Total expenditure on dike	....	....	1,184.00	....	....	3,053.23

	Dike K.	Dike L.
Brush used per square of mattress.......................................cords..	0.497	0.478
Poles used per square of mattress ....number..	.617	....
Wire used per square of mattress......................................pounds..	.314	.312
Cost of weaving 1 cord of brush..	$1.051	$1.145

[a] Work not completed.

Exhibit of field expenditures on Reids Bend revetment.

[Work not completed.]

	Quantities.	Cost per unit.	Cost per item.
Grading bank, 15-foot stage.			
Labor grading bank ... linear feet..	6,510	$0.334	$2,172.38
Anchor piles.			
Piles delivered at work	46	1.60	73.60
Labor driving piles	46	2.926	134.58
Fuel (estimated)	....	....	3.68
Total cost of piles in place	46	4.605	211.86
Mattress.			
Brush purchased on barges ... cords..	2,145.3	1.00	2,145.30
Poles purchased on barges ... number..	3,289	.075	246.37
Wire purchased ... pounds..	12,103	.022	261.42
Towage	....	....	2,537.89
Labor weaving mattress ... squares..	5,106.4	.381	1,950.14
Total cost of mattress ... do....	5,106.4	1.399	7,141.12
Stone.			
Stone on bank at Ives Point, Scotts Eddy, and Natural Steps	4,882.3	.53	2,587.62
Stone on bank at Scotts Eddy and Natural Steps	1,967.9	.49	964.27
Stone on bank at Ross Hollow	1,139	.35	398.65
Stone in place in work	360.9	.90	324.81
Loading stone	7,989.2	.121	968.16
Towage	7,989.2	.213	1,704.40
Labor placing stone	7,989.2	.197	1,570.97
Inspecting, loading of stone	7,301.5	.015	107.86
Total cost of stone in place ... cubic yards..	8,350.1	1.033	8,626.74
Miscellaneous.			
Repairs to plant, labor, material, etc	....	....	308.06
Property purchased	....	....	63.30
Care of property during high water	....	....	124.52
Moving plant	....	....	121.13
Total miscellaneous	....	....	617.01
Total field expenditures	....	....	18,769.11

Brush used per square of mattress ... cords..	0.420
Poles used per square of mattress ... number..	.644
Wire used per square of mattress ... pounds..	2.377
Cost of weaving 1 cord of brush	$0.909

Exhibit of field expenditures on Dike M.

[Work not completed.]

	Quantities.	Cost per unit.	Cost per item.
Grading bank.			
Labor grading bank ...linear feet..	200	$0.171	$34.39
Mooring piles.			
Piles purchased delivered at work	8	3.15	25.20
Labor driving piles	8	1.557	12.46
Fuel (estimated)			.80
Total cost of piles in place	8	4.808	38.46
Mattress.			
Brush purchased on barges ...cords..	180	1.00	180.00
Poles purchased on barges ...number..	290	.075	21.75
Wire purchased ...pounds..	1,324	.022	28.60
Towage			212.94
Labor weaving mattress ...squares..	369	.408	150.47
Total cost of mattress ...do....	369	1.609	593.76
Stone.			
Stone on bank at Ives Point ...cubic yards..	500.6	.53	265.31
Stone on bank at Scotts Eddy and Natural Steps ...do....	188.9	.49	92.56
Labor loading stone ...do....	689.5	.12	82.74
Towage		.213	147.07
Labor placing stone ...cubic yards..		.163	112.47
Total cost of stone in place ...do....	689.5	1.015	700.15
Miscellaneous.			
Repairs to plant, labor, material, etc			33.14
Property purchased			5.27
Care of property during high water			6.45
Surveys			22.25
Moving plant			10.29
Total miscellaneous			77.40
Total field expenditures			1,444.16

Brush used per square of mattress ...cords..	0.488
Poles used per square of mattress ...number..	.786
Wire used per square of mattress ...pounds..	3.588
Cost of weaving 1 cord of brush	$0.836

Exhibit of field expenditures on Dikes N and O.

[Work not completed.]

	Dike N.			Dike O.		
	Quantities.	Cost per unit.	Cost per item.	Quantities.	Cost per unit.	Cost per item.
Grading bank.						
Labor grading bank........linear feet..	200	$0.178	$35.65	200	$0.193	$38.57
Mooring piles.						
Piles purchased delivered at work......	7	2.40	16.80	17	1.882	32.00
Labor driving piles.....................	7	2.671	18.70	17	1.483	25.21
Fuel (estimated)........................	....	....	.70	....	....	1 70
Total cost of piles in place.......	7	5.171	36.20	17	3.465	58.91
Mattress.						
Brush purchased on barges......cords..	185.3	1.00	185.30	202	1.00	202.00
Poles purchased on barges....number..	300	.075	22.50	365	.075	27.37
Wire purchased...............pounds..	1,367	.022	29.53	1,581	.022	34.15
Labor weaving mattress......squares..	365	.042	151.37	425	.328	158.99
Towage.................................	....	....	219.20	....	....	239.00
Total cost of mattress..squares..	365	1.666	607.90	425	1.556	661.51
Stone.						
Stone on bank at Ives Point..cub. yds..	212.1	.53	112.41	732.3	.53	388.12
Stone on bank at Scotts Eddy and Natural Steps...............cubic yards..	413	.49	202.87	491.7	.49	240.93
Labor loading stone..............do....	625.1	.12	75.01	1,224	.12	146.88
Towage.................................	....	.213	133.33	....	.213	261.07
Labor placing stone.......cubic yards..	625.1	.153	95.96	1,224	.216	264.62
Total cost of stone in place, cubic yards..........................	625.1	.990	619.08	1,224	1.063	1,301.62
Miscellaneous.						
Repairs to plant, labor, material, etc....	....	....	33.14	....	....	99.42
Property purchased.....................	....	....	5.27	....	....	15.79
Care of property during high water....	....	....	6.45	....	....	19.35
Surveys	....	....	22.25	....	....	22.25
Moving plant...........................	....	....	10.29	....	....	30.90
Total miscellaneous.............	....	....	77.40	....	....	187.71
Total field expenses.............	....	....	1,376.23	....	....	2,248.82

	Dike N.	Dike O.
Brush used per square of mattress....................................cords..	0.508	0.475
Poles used per square of mattress....................................number..	.824	.858
Wire used per square of mattress....................................pounds..	.374	.372
Cost of weaving 1 cord brush	$0.817	$0.787

Exhibit of field expenditures on Dike E and training wall at Dike F.

	Dike E.			Training wall at Dike F.		
	Quantities.	Cost per unit.	Cost per item.	Quantities.	Cost per unit.	Cost per item.
Grading bank.						
Labor grading bank.........linear feet..	250	$0.168	$41.68	....	....	....
Mooring piles.						
Piles delivered at work..................	12	2.10	25.20	33	$1.612	$53.20
Labor driving piles......................	12	5.36	64.31	33	4.948	163.30
Fuel (estimated).........................	....	....	.96	....	....	2.64
Total cost of piles in place........	12	7.54	90.47	33	6.640	219.14
Mattress.						
Brush purchased on barges......cords..	351.7	1.00	351.70	400	1.00	400.00
Poles purchased on barges....number..	388	.075	29.10	315	.075	23.63
Towage..................................	....	....	416.06	....	....	473.20
Wire purchased...............pounds..	1,560	.022	33.70	1,400	.022	30.24
Labor weaving mattress......squares..	598	.602	360.01	843.7	.548	462.11
Total cost of mattress......do....	598	1.991	1,190.57	843.7	1.647	1,389.18
Stone.						
Stone purchased delivered in place, cubic yards..............................	3,765.6	.80	3,012.48	2,591.3	.80	2,073.04
Supervision, inspection, etc.............	3,765.6	.030	112.04	2,591.3	.038	95.30
Total cost of stone in place, cubic yards..........................	3,765.6	.830	3,124.52	2,591.3	.838	2,168.34
Miscellaneous.						
Repairs to plant, labor, material, etc	....	....	55.92	....	....	49.70
Property purchased	....	....	11.87	....	....	9.49
Care of property during high water	....	....	....	....	....	9.67
Moving plant.............................	....	....	22.72	....	....	18.17
Total miscellaneous	....	....	90.51	....	....	87.03
Total field expenditures	....	....	4,537.75	....	....	3,863.69

	Dike E.	Dike F.
Brush used per square of mattress ....cords..	0.588	0.474
Poles used per square of mattress ....number..	.649	.374
Wire used per square of mattress...................................pounds..	2.609	1.659
Cost of weaving brush ....per cord..	$1.023	$1.155

Exhibit of field expenditures on extension of Newtons and Greathouse bends revetments.

	Newtons Bend.[a]			Greathouse Bend.[b]		
	Quantities.	Cost per unit.	Cost per item.	Quantities.	Cost per unit.	Cost per item.
Grading bank, 15-foot stage.						
Labor grading bank........linear feet..	1,700	$0.149	$253.16			$9.06
Anchor piles.						
Piles delivered at work	21	1.60	33.60	16	$1.50	24.00
Labor driving piles	21	3.221	67.77	16	1.27	20.33
Fuel (estimated)			1.68			1.60
Total cost of piles in place	21	4.907	103.05	16	2.871	45.93
Mattress.						
Brush purchased on barges......cords..	481.1	1.00	481.10	224.1	1.00	224.10
Poles purchased on barges....number..	716	.075	53.70	400	.075	30.00
Wire purchased...............pounds..	1,605	.022	34.67	800	.022	17.28
Towage			569.14			265.11
Labor weaving mattress......squares..	1,026	.499	511.78	462	.346	158.79
Total cost of mattress......do....	1,026	1.609	1,650.39	462	1.505	695.28
Stone.						
Stone distributed on bank at work, cubic yards	2,023.8	.625	1,264.88			
Stone on bank, Davidsons Field, cubic yards				183	.395	72.26
Stone on bank, Ives Point..cubic yards..				429.6	.53	227.68
Stone on bank, Scotts Eddy and Natural Steps..............cubic yards..				275.4	.49	134.94
Labor loading stone.............do....				888	.178	158.40
Towage						189.41
Labor placing stone	1,923.8	.239	459.83	888	.269	238.88
Total cost of stone in place, cubic yards			1,724.71	888	1.150	1,021.57
Miscellaneous.						
Repairs to plant, labor, material, etc			49.70			66.28
Property purchased			9.49			10.51
Care of property during high water			18.17			12.90
Moving plant			9.67			20.60
Total miscellaneous			87.03			110.29
Total field expenditures			3,818.34			1,882.13
Snag boat working on rack heap			773.60			

	Newtons Bend.	Greathouse Bend.
Brush used per square of mattress...cords..	0.469	0.485
Poles used per square of mattress...number..	.697	.866
Wire used per square of mattress...pounds..	1.564	1.731
Cost of weaving 1 cord of brush	$0.940	$0.708

[a] Work not completed.

[b] Work practically completed.

Exhibit of field expenditures, repairs to Dike D, near Little Rock, Ark.

Expended fiscal year 1896 (p. 1661 of Annual Report)	$297.94
Completing grading bank	8.75
321¼ cubic yards stone on bank, at 65 cents per cubic yard	208.87
Placing 321¼ cubic yards stone	42.56
Total field expenditures, repairing Dike D	558.12

SURVEYS.

The river and harbor act of June 3, 1896, provides for examinations and surveys at or near Fort Smith, Van Buren, Dardanelle, Little Rock, and Pine Bluff, to determine whether or not, by reason of dikes or other Government works, any part of the harbors or river banks in their vicinity have been so injured or endangered that the Government should guard against or remedy the same. The examinations and surveys were made and separate reports were rendered.

PLANT.

The plant formerly held under the head "Removing obstructions in Arkansas River, Arkansas and Kansas," having been by authority consolidated with that under the head "Improving Arkansas River," the repairs to all are here reported regardless of appropriation under which the plant had been employed during this year.

U. S. snag boat Beauregard.—(Launched July 20, 1893.) Thirty-two hundred and eight feet of new decking; 12 ventilating doors placed in hull bulkheads; 2 new hatchways in main deck; new head block for shears; 2 new rudders, complete; doctor repaired with 2 new beam shafts, plungers turned, new packing and new valves, exhaust from engine changed so that it can be thrown into the stacks; new floor, waste heads and channel ways for heaters; one new sheet in mud drum; new worm wheel, worm, shafts, crank plate, and 3 sets of pinions for capstans; new floor in kitchen and pantry; new roof to pilot house and many minor repairs to the boat throughout. Boat also painted. Condition of boat's hull is poor.

U. S. snag boat Wichita.—(Present hull launched December 29, 1888; docked December 1895.) Starboard crank bushed and reset; 2 sets engine brasses; 1 new plunger for doctor; 2 doctor chambers rebored; old stacks taken off and stacks from the *C. B. Reese* put up instead; 6 new floor timbers; 3 new bow plank; sheathed 224 square feet of bow; 3 new connections for steam siphons; 1 new flue in starboard boiler to replace one collapsed May 1, 1897. Boat painted one coat above water line. Condition bad.

U. S. towboat Cleveland.—(Launched November 24, 1893.) Hold whitewashed; pilot house roof recanvassed; cabin roof partially repaired and painted; new stacks and breeching (breeching not yet placed); new port crank; new water chambers and valves for boiler feed pump; hull calked above water line. Condition fair.

Pile driver No. 2.—Hull condemned, machinery placed on barge No. 107 (20 by 60 by 3).

Pile driver No. 4.—Sunk at Pine Bluff, machinery stored at Little Rock.

Pile driver No. 3.—New leads and braces and new rakes.

Barges.—A195, A295, A395, and A495, calked above water line.

Barge, A192.—Center bulkhead rebuilt; 2 new head blocks; new deck frame and deck complete; calked above water line.

Barge, B194.—New deck, complete; calked and painted above water line.

Barges (20 by 60 by 3.—Nineteen of these calked and repairs made to rakes and decks where required. Condition of all bad.

Quarterboats Lisette and Monterey.—Calked above water line and rakes repaired. New deck on the *Monterey.*

Dredge No. 1.—Sunk at Little Rock; machinery stored at Little Rock.

Plant condemned.—Quarterboat *Greenwich*, hull of Fort Smith store barge, housing of Pine Bluff store barge, Little Rock store barge, and barges numbered 116, 117, 120, and 124 condemned. The housing of Fort Smith store barge was placed on the hull of the Pine Bluff store barge.

Plant built.—Dredge *Van Frank.* This was reported in last annual report as *Dredge No. 2* building at Fort Smith, Ark. The first shipment of lumber was received March 27, 1896; construction of hull began April 17, 1896; hull launched May 30, 1896; erection of cabin begun June 13, and completed August 2; machinery received June 2, and all in place July 29; dredge tested in September. The hull is built of long leaf yellow pine, is 100 feet long, 37 feet wide, and 5¼ feet deep, and is of 2-foot draft when trimmed for towing. The dipper is of 1¼ cubic yards capacity, the A frame and boom are of steel; length of boom, 50 feet. The boat yard expenses are shown in the tabulation below, totals only being shown.

	Hull.	Cabin.	Machinery.
Material	$1,758.40	$494.41	$8,074.82
Labor, subsistence, and sundries	2,925.59	613.70	546.12
Totals	4,683.99	1,108.11	8,620.94
Total cost of dredge			14,413.04

Since the dredge was placed in commission the following additions have been made: Providence capstan from snag boat *Sheldon* placed, exhaust heads placed on the exhaust pipes from the hoisting engines and from swinging engines, railing placed around boiler deck, steel plates placed on stern spud, interior of boiler and engine room painted. Also made such repairs as were necessary to keep the dredge in good working order.

Plant for temporary relief work.—This is a small light-draft outfit, consisting of one tent boat and 5 scows, one of which is fitted with a light pile-driving frame. It was built at Pine Bluff in May and June, 1897, at a cost of $321 for material and $218 for labor, making total cost $539.

CHANNEL AND RESULTS OF WORK.

The Arkansas River is a stream whose bed and banks are to a great extent composed of a sandy loam. This material is eroded very easily, and as a result the channel of the stream is continually changing, the concave banks wearing away, and the opposite point bars building out.

From Little Rock to the mouth (173 miles) the river valley is entirely alluvial, and the entire bank is liable to cave if attacked by the water. Above Little Rock the conditions are the same, except at those places where the stream runs next to the hills that jut out into the valley. Even though the valley be very narrow, the character of the bottom land is the same.

From the data in the possession of this office, which is not very complete, the average amount of bank caved in per mile per year from Little Rock to the mouth is about 7.64 acres; from Little Rock above, about 1.99 acres.

Ordinarily, in low water there is approximately 3 feet of water on the shallowest crossings from the mouth to Silver Lake, a distance of about 40 miles. From there up to Webbers Falls, in Indian Territory, there is no great difference in depth, being about 16 inches on the shallowest crossings to 20 miles above Little Rock, and 12 to 14 inches from there on up. The increased depth in the lower 40 miles of the river is evidently due to a gentler slope and to the effect the backwater from the Mississippi has on this portion of the stream.

The checking of the current by this backwater causes immense deposits of material in that portion. When a concave bank wears away the opposite point bar builds up in two or three years to near the height of the original bank, thus keeping the river bed narrow, while above, where this condition exists, the high concave banks wear away and the bars opposite build up very slowly, and as a consequence, when the river rises 2 or 3 feet, it spreads out until it is wider than in the lower part of the stream.

This condition, of course, requires more rainfall to produce a navigable depth, and causes, in a great many cases, a different channel in high and low water, leveling the bars and filling up the low-water channel to such an extent as to make it a difficult task for the low-water current to cut out its original channel.

The low-water channel, as a consequence, wanders between these high banks after different rises.

Prior to fiscal year 1895, works upon this river were for the improvement of detached reaches. Some of these works gave satisfactory results, others were not kept in good repair, and the improvement in the channel was only temporary. In relation to each other the works were remote and there was no increase of channel depth for a length of river sufficient for a steamboat trade. Beginning with the fiscal year 1895, effort has been made to work systematically over a reach of river of sufficient length to be of some benefit to navigation. The amounts appropriated have been small in comparison with the amounts of work proposed in the project and the length of river believed to be permanently improved is not yet large. It is believed that a low-water depth of 2 feet 6 inches to 3 feet has been obtained over the crossings in the first 21 miles above Little Rock. These crossings formerly had on them low-water depths of 14 to 18 inches. The plan followed in the improvement of this 21-mile reach has been that of holding the concave side of the bends with revetments and of holding the head of the bars below the bends with dikes. No attempt has been made to contract the water widths by works on both sides of the stream, as it is believed that by holding the concave banks and the head of the bars below the river will narrow itself, both in the bends and on the crossings.

The results obtained in this reach of river seem to warrant a continuance of the work. Work of this character can be carried on more economically where there are funds in sufficient quantity available to enable the engineer in charge to take advantage of the work done by the river itself. The banks of the Arkansas River cave rapidly, and the various bends and crossings assume all kinds of shapes in a few years.

The first essential in regulation work being permanency of bends and crossings, and since the resultant increase of depth depends largely on the shape of bends and crossings, it follows that to obtain the greater results in the improvement of a certain reach of river for the least money, that the engineer should be able to protect and hold the various bends and crossings just at the time when the river itself has given them the best shape.

If this plan is pursued and funds are not available to protect and hold the bends and crossings above the improved places, changes in the unimproved part may cause an entire loss of the work already done. To commence at a certain permanent point and work down the river, which plan one is forced to pursue if appropriations are small, necessitates either the protection of bends and crossings in the shape in which they are found when they are reached or the shaping of them before protecting. The first system does not give the greatest obtainable depth and the second is very expensive.

The works for temporary relief produced good results during the low-water season of last fall, and it is proposed to continue this work.

Money statement.

July 1, 1896, balance unexpended		$169,805.71
June 30, 1897, amount expended during fiscal year	$120,196.69	
Less refundments of overpayments	36.37	
		120,160.32
July 1, 1897, balance unexpended		*49,645.39
July 1, 1897, outstanding liabilities	$7,000.00	
July 1, 1897, amount covered by uncompleted contracts	2,000.00	
		9,000.00
July 1, 1897, balance available		40,645.39
Amount (estimated) required for completion of existing project		Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Prior to 1886 appropriations were made for special works. The act of August 5, 1886, and subsequent ones, made appropriation for the improvement of the river in accordance with approved project. The acts of August 17, 1894, and June 3, 1896, also made appropriations for removing obstructions and operating snag boats.

The appropriations are as follows:

SPECIAL WORK.

June 14, 1880 (Pine Bluff)	$25,000.00
March 3, 1881 (Pine Bluff)	23,000.00
August 2, 1882 (Pine Bluff)	20,000.00
July 5, 1884 (Pine Bluff)	55,500.00
July 5, 1884 (Fort Smith)	5,000.00
August 5, 1886, part (Pine Bluff)	8,000.00
August 5, 1886, part (Fort Smith)	13,000.00
August 5, 1886, part (Dardanelle)	10,000.00
Total	159,500.00

PRESENT PROJECT.

August 5, 1886 (part)	$44,000.00
August 11, 1888	150,000.00
September 19, 1890	180,000.00
July 13, 1892	250,000.00
August 17, 1894 (part)	240,000.00
June 3, 1896 (part)	85,000.00
Total	949,000.00

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* $5,449.34 for removing obstructions; $44,196.05 for project.

REMOVING OBSTRUCTIONS.

August 17, 1894 (part)		$10,000.00
June 3, 1896 (part)		15,000.00
Total		25,000.00
Total appropriations		1,133,500.00
Expended to June 30, 1896	$969,047.20	
Less sales and refundments	5,352.91	
Net expenditures to June 30, 1896		963,694.29
Unexpended July 1, 1896*		169,805.71
Expended on special work to June 30, 1896		159,500.00
Expended on project to June 30, 1896		798,194.29
Expended removing obstructions to June 30, 1896		6,000.00
Total		963,694.29

Abstract of bid for subsistence supplies for improving Arkansas River, Arkansas, received in response to advertisement dated July 9, 1896, and opened August 7, 1896.

No.	Name and address of bidder.	Total.
1	H. J. George Grocer Co., Little Rock, Ark	$3,698.51

Recommended for acceptance.

List of contracts in force June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Expiration of contract.
Zeb Ward, jr	Aug. 14, 1895	Sept. —, 1895	(*a*)
H. J. George Grocer Co	Sept. 16, 1896	Aug. 25, 1896	July 31, 1897

a Work has been completed, but contract has not been closed.

COMMERCIAL STATISTICS.

There are no "long trade" packets on this river, except by boats between Pine Bluff and Memphis, Tenn. Boats out of Fort Smith ply the river down to Roseville and up to Webbers Falls. The Little Rock boats go to Dardanelle and Roseville above and to Pine Bluff and Cummings below. The trips to Pine Bluff and below are made only when freights are assured them. The river trade from Pine Bluff to Memphis is handled by a packet line out of Memphis, Tenn., that endeavors to navigate the river the year round.

The results of thorough snagging operations show, in the present commerce report, in the increased amount of timber transported. Navigation having been made easier, timber men have no difficulty in finding towboats to come into the river to handle their material. The greater portion of timber taken from this stream is for northern and eastern markets. The cooperage stuffs go to New Orleans for export. There is a slight increase in the amount of plantation products, which would be still further increased had report of the commerce centering at Fort Smith been received. Railroads closely follow the river throughout its entire length, and the freight rates on the railways are influenced to a great extent by the river.

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* $19,000 of this for removing obstructions and $150,805.71 for work on project.

List of stern-wheel boats navigating Arkansas River, Arkansas, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Load draft.				Between—	Round trips.	Passengers.
		Steamers.		Barges.				
		Ft.	In.	Ft.	In.			
G. W. Mayo	124.1	3	0	2	6	Fort Smith and ?	(?)	(?)
City of Little Rock	219.1	4	6	3	0	Little Rock and Cummings	3	451
						Little Rock and Cardens Bottom	6	
						Little Rock and Dardanelle	14	
						Little Rock and Pine Bluff	9	
						Little Rock and New Orleans	2	
New Mary Morgan	137	3	0	2	6	Dardanelle and Roseville	21	600
						Dardanelle and Little Rock	8	
						Dardanelle and Cummings	2	
Dardanelle[a]	164	3	0	....		Little Rock and Dardanelle	16	171
						Little Rock and Pine Bluff	15	
Irma[a]	151.4	3	0	2	0	....do	3	125
						Little Rock and points below Dardanelle.	29	
U. K. Riggs	119.6	3	0	3	0	Little Rock and White Bluff	2	5
						Little Rock and Hensleys Island	1	2
						Little Rock and Dardanelle	5	20
						Little Rock and Cardens Bottom	1	5
						Little Rock and Simons Landing	1	2
Luella Brown[b]	102	2	0	4	0	Greenville, Miss., and ?	(?)	(?)
Louis Houck	620.5	6	6	6	6	St. Louis, Mo., and Cut-Off	2	....
Eugene	508.9	5	0	....		Memphis, Tenn., and Pine Bluff	20	576
J. N. Harbin	341.7	3	0	....		....do	28	771
						Memphis, Tenn., and Jenkins	2	
						Memphis, Tenn., and Fish Place	1	
						Memphis, Tenn., and Rob Roy	2	
						Memphis, Tenn., and Swan Lake	3	
						Memphis, Tenn., and Garretsons	1	
L. E. Patton[b]	92	3	6	6	0	Memphis and Gonders	3	....
Crescent[b]	(?)	(?)		(?)		New Orleans and ?	(?)	(?)
J. C. Atlee	(?)	(?)		(?)		Memphis and ?	(?)	(?)
Wm. Druhe, No. 2[c]	179.2	3	6	3	0	Fort Smith and Redland	(?)	(?)
						Fort Smith and points above Roseville	(?)	(?)

[a] Built at Little Rock in summer of 1896. [b] Partial report. [c] No report.

Classification of commerce reported.

	1897.		1896.	1895.	1894.
	Estimated value.	Tons.	Tons.	Tons.	Tons.
Cotton	$896,800	5,605	4,437	4,274	7,213
Cotton seed	98,280	12,285	9,576	9,146	38,310
Hides and skins	2,250	30	8	12	31
Live stock	6,320	158	241	175	287
Lumber	3,200	640	4,112	2,733	2,616
Staves and bolts	29,430	8,175	170	513	250
Provisions	93,600	585	3,580	2,033	4,617
Grain	4,450	445	1,579	1,992	3,185
Saw logs	46,438	23,219	19,070	17,400	1,240
Hewn piles	178,950	11,930	1,545	....	....
Miscellaneous	297,500	2,975	9,943	12,220	5,784
Totals	1,657,218	66,077	54,261	50,498	63,563

The Arkansas River is paralleled on the north side from Fort Gibson, Ind. T., to Swan Lake Landing, Arkansas, by the following railroads: Fort Gibson to Fort Smith, by the Kansas and Arkansas Valley; Fort Smith to Van Buren and Little Rock, by the Little Rock and Fort Smith Railway; Little Rock to Rob Roy, by the Little Rock Branch of the St. Louis Southwestern Railway; Rob Roy to Swan Lake Landing, by the Pine Bluff and Swan Lake Railway. At no point are these railroads over 12 miles from the river. On the south side of the river, from Little Rock to Douglas Landing, the Little Rock, Mississippi River and Texas Railway lies within 6 miles of the river. The river is crossed at Fort Smith by the Kansas and Arkansas Valley Railway, at Van Buren by the Texas Branch of the St. Louis and San Francisco Railway, at Little Rock by the St. Louis, Iron Mountain and Southern Railway and by the Little Rock Junction Railway, and at Rob Roy by the St. Louis Southwestern Railway.

V 3.

IMPROVEMENT OF WHITE RIVER, ARKANSAS.

OBJECT.

To secure and maintain a navigable channel of not less than 2 feet in depth at low water above Newport and not less than 5 feet in depth at low water from Newport to the mouth.

PROJECT.

To remove snags and overhanging trees; to blast and dredge bowlders and rocks or gravel reefs; to contract the channel where necessary by dams and spur dikes.

WORK DONE IN PREVIOUS YEARS.

The work of previous years is shown on pages 1668–1680 of Annual Report for 1896.

OPERATIONS DURING THIS FISCAL YEAR.

Excepting small repairs made to the revetments at Batesville, the work this year has been confined to operating the snag boat *Sheldon* and caring for property. In the earlier part of this fiscal year the quarter boat *Albany*, pile driver, store boat, and six barges were laid up at Batesville in the care of watchmen. On the night of January 2, this outfit was swept from its moorings by a freshet. All pieces, excepting one barge, were safely landed. The snag boat *Sheldon*, from Newport, gathered the fleet and towed it to that place, where it has remained. The one barge that was not landed by the watchmen grounded on a bar and is still there, the river having fallen too rapidly for the *Sheldon* to reach it. The snagging operations of the year were confined to the portions of the river below Batesville, and the work done is given in tabulation below:

Snagging operations of the Sheldon during the year.

Months.	Snags removed.	Trees cut.	Drifts broken.	Between—
July	45	5	....	Batesville and Rutherford's gin.
	84	6	1	Newport and mouth of Black River.
October	24	7	....	Newport and Little Red River.
	77	45	2	Indian Bay and Clarendon.
November	149	202	2	Clarendon and Little Red River.
	10	100	....	Mouth of River and St. Charles.
December	65	875	4	Arkansas River Cut-off and Black River.
January	12	566	....	Black River and Batesville.
February	60	170	3	Do.
May	96	1,196	....	Augusta and Batesville.
June	22	....	....	Jacksonport and Old Franks.
Total	594	3,172	12	

PLANT.

Snag boat Sheldon.—Renewed 300 square feet of deck and sheathed main deck forward of capstans; sheathed bow with No. 7 plate iron; new shears; one new ring in each stack and new breeching; took out the Providence capstan and replaced it with a Sweeney capstan from Little Rock fleet; new bed plates; new worm wheels, new worms, and new reversing gear for both capstans; new worm shaft for one capstan; faced all valves; fire pump supply pipes made independent of doctor supply; boat painted above water line and minor repairs made to cabin.

Snag boat Riverside (*hand propelled*).—The hull of this having become unserviceable, authority was obtained to build a new one and transfer to it the upper works and machinery from the old, the cost to be paid from appropriations for improving Current, Black, and White (Cache River allotment) rivers, one-third each. This work was done at Newport, Ark. The first lumber was received March 13, but that to replace rejected material was not delivered until May 11. The hull was launched June 11. The old cabin and machinery was transferred to it and all work was completed June 30, 1897. The new hull is of Louisiana pine; it is 84 feet long, 22 feet wide, and 3 feet deep; with working outfit on board the draft is 11 inches.

Expense bill, rebuilding Riverside.

MATERIAL.

Lumber, 13,923 feet B. M.	$262.90
Spikes and nails, 900 pounds	25.55
Drift bolts and iron, assorted	166.70
Oakum, 8 bales	32.00
Calking cotton, 120 pounds	14.40
Pitch, 1 barrel	4.00
Paint, 300 pounds	16.50
Oil, linseed, 28 gallons	10.64
Worm wheels, 2	31.00
Worm, 1	4.75
Reversing gear for 1 capstan	65.00
Miscellaneous	7.70
Total material	641.14

LABOR.

Engineer (steam)	52.50
Carpenters' work	323.80
Calking	151.24
Common labor	213.36
Supervision	90.75
Machinists' work	13.55
Total labor	845.20
Total boatyard expenditures	1,486.34

Quarterboat Albany and barges.—No repairs have been made to this plant. Four of the barges (Nos. 2, 3, 4, and 5) are in fair condition; the rest of it is bad.

RESULTS OF THE WORK.

The snagging operations of this year have been of much benefit to navigation, especially so between the mouth of Black River and Batesville. As to the improvement by means of dams and spur dikes there is little to be said. The 2-foot low-water depth above Black River has not been obtained. Blasting and dredging, as provided for in project, will be continued, but no recommendation is made for continuation of improvement by contraction works. The small improvement obtained by this method was fully reported in Annual Report for 1896, pages 1680 to 1682. To maintain the dams and spur dikes previously built and to operate a snag boat, $10,000 will be required annually.

CHANNEL.

From the Mississippi River to Black River (265 miles) 3½-foot draft can be taken on low water. Between Black River and Batesville, 22 inches was the depth of the water in the available low-water channel last fall. Above Batesville there are no attempts to navigate the river when it is less than 1 foot above low water.

Money statement.

July 1, 1896, balance unexpended	$38,476.90
June 30, 1897, amount expended during fiscal year	*10,981.93
July 1, 1897, balance unexpended	†27,494.79
July 1, 1897, outstanding liabilities	650.00
July 1, 1897, balance available	26,844.97
Amount (estimated) required for completion of existing project	14,815.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	14,815.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Appropriations for this river has been partly for limited reaches, partly for the whole river, and partly for this river in combination with others. Of the distribution of the expenditures under the latter appropriations I am unable to render any information.

The appropriations for this river separately, and for reaches of it, are as follows:

June 23, 1874	$50,000.00
August 14, 1876	10,000.00
March 3, 1879	10,000.00
June 14, 1880	20,000.00
June 14, 1880	5,000.00
March 3, 1881	8,000.00
August 2, 1882	6,000.00
August 2, 1882	4,000.00
July 5, 1884	35,000.00
August 5, 1886	18,000.00
August 11, 1888	25,000.00
September 19, 1890	30,000.00
July 13, 1892	75,000.00

August 17, 1894		$52,000.00
June 3, 1896		22,000.00
Total		370,000.00
Expended to June 30, 1896	$331,745.32	
Less sales and refundments	222.22	
Net expenditure to June 30, 1896		331,523.10
Unexpended July 1, 1896		38,476.90

COMMERCIAL STATISTICS.

The commerce arising on Upper White River centers mainly at Newport; that arising on Lower White centers at Devall Bluff and Clarendon. There is a small amount that passes over the river between Des Arc and Newport, but information as to the amount has not been received.

No steamboat has reported navigating the river above Dentons Ferry (405 miles above the mouth) during the year ending June 1, 1897. From January 1 to May 15 steamboats report "fair navigation to Buffalo Shoals."

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* Of this, $349.41 expended in removing obstructions in Cache River.

† Of this, $3,650.59 to be expended in removing obstructions in Cache River.

List of stern-wheel boats navigating White River, Arkansas, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Load, draft.		Between—	Round trips.	Passengers.
		Steamers.	Barges.			
		Ft. In.	*Ft. In.*			
Rex	144	3 6	3 6	Desarc and Devall Bluff	144	719
J. A. Woodson	219.8	3 6	....	Newport and Oil Trough	3	75
				Newport and Black River	49	(?)
Memphis	110.3	4 6	4 6	Memphis and (?)	4	....
A. R. Bragg	162.7	3 6	....	Newport and Black River	3	(?)
				Devall Bluff and Indian Bay	32	640
A. Saltzman	36	3 6	3 6	Negro Hill and Judsonia	11	....
Louisa Stecker	13	2 6	....	Indian Bay and Judsonia	3	24
Emma	5.9	4 0	3 0	Devall Bluff and Cache River	12	....
				Devall Bluff and Augusta	13	....
Mary F. Carter	50.4	3 0	....	Clarendon and Indian Bay	87	310
Ozark Queen *a*	135.9	3 0	....	Newport and McBee Landing	9	260
				Newport and Buffalo City	11	
				Newport and Rapides	1	
				Batesville and Sylamore	1	
Tycoon *a*	64.5	3 0	2 0	Newport and McBee Landing	5	500
				Newport and Dentons Ferry	1	
				Newport and Buffalo City	11	
				Newport and Calico Rock	2	
				Newport and Black River	(?)	
				Newport and points below	(?)	
Dauntless *b*	73.5	2 6	2 0	(?)	(?)	(?)
Mayflower *c*	(?)	(?)	(?)	Memphis and (?)	(?)	(?)
G. M. Sivley ‡	96.9	5 0	5 0	Newport and Black River	(?)	(?)
Josie Sivley ‡	(?)	(?)	(?)	Newport and Buffalo City		
				Newport and Little Red River		

a Built at Batesville in summer of 1896.
b Burned November 10, 1896, 10 miles below Batesville. No report of business rendered.
c No report.

Classification of commerce reported.

Articles.	1897.		1896.	1895.	1894.
	Estimated value.	Tons.	Tons.	Tons.	Tons.
Cotton	$617,600	3,860	4,693	4,928	3,968
Cotton seed	9,000	1,125	1,098	6,721	2,246
Hides and skins	6,525	87	37	90	20
Live stock	4,400	110	102	101	549
Lumber	14,325	2,865	2,078	4,619	5,461
Staves and bolts	33,692	9,359	6,829	5,203	2,772
Provisions	688,320	4,302	1,748	8,005	436
Grain	9,740	974	725	647	557
Square timber	18,744	2,840	....	2,750	....
Saw logs	27,730	13,865	13,188	23,751	21,644
Railroad ties	39,663	14,690	25,125	18,520	5,940
Cedar	592,875	15,810	16,800	2,080	....
Miscellaneous	372,500	3,725	2,459	1,344	2,200
Total	2,435,114	73,612	74,882	78,759	45,798

From Batesville to Jacksonport the White River is paralleled on the left bank by the Diaz and Batesville branch of the St. Louis, Iron Mountain and Southern Railway; from Jacksonport to Newport it is paralleled by White and Black River Valley Railway, also on the left bank. Three miles below Newport it is crossed by the main line of the St. Louis, Iron Mountain and Southern Railway. This railroad lies within 12 miles of the river (on the right bank) to Augusta. On the left bank, between Newport and Augusta, the White and Black River Valley Railway lies within an average distance of 9 miles. Near Augusta the river is crossed by the Bald Knob and Memphis branch of the St. Louis, Iron Mountain and Southern Railway, and near Devall Bluff by the Little Rock and Memphis Railway; at Clarendon, by the St. Louis Southwestern Railway.

COMMERCIAL STATISTICS OF CACHE RIVER, A TRIBUTARY TO WHITE RIVER.

The last two river and harbor bills have carried provision that some of the money appropriated for improvement of White River may be expended on Cache River. The Cache River reports having been dropped, the commercial statistics of that stream are here embodied as part of White River report.

It is not believed that full report of rafted commerce has been received. In years past much timber has been rafted from this stream to New Orleans. It is probable that the same occurred this year, but report of 1,500 tons is all that has been received.

Much of the cooperage stuff that passed over this river is for export via New Orleans. The river for about three months each year can be navigated by boats with barges of 5¼ and 6 feet draft. These boats can not pass the Little Rock and Memphis Railway Bridge, which is only 31 miles above the mouth.

Practically all of the material rafted and barged on this stream comes from points over 25 miles above the bridge.

Classification of commerce reported.

Articles.	1897.		1896.	1895.
	Estimated value.	Tons.	Tons.	Tons.
Saw logs	$23,840	11,920	7,670	12,186
Railway ties	....	....	....	417
Lumber	3,200	800	44	....
Piling	5,170	940	....	....
Staves, bolts, and headings	75,550	20,980	13,034	....
Total	107,760	34,640	20,748	12,603

V 4.

IMPROVEMENT OF BLACK RIVER, ARKANSAS AND MISSOURI.

The first independent appropriation for this river was made by act of Congress approved June 14, 1880, and the report for that fiscal year implies that the appropriation was based upon report of an examination provided for by act of Congress approved March 3, 1879. (Annual Report Chief of Engineers, 1880, Part II, p. 1326.)

Original condition.—The general obstructions to navigation were shoals, snags, logs, and leaning timber. The first 31 miles below Poplar Bluff was a mass of snags and leaning trees.

Object of improvement.—To improve navigation between Poplar Bluff, Mo., and the mouth.

Project.—Procure and operate a light-draft snag boat, close chutes by dams, and improve shoals by wing dams. In late years no dams have been erected.

Work done in previous years.—On page 1686 of Annual Report for 1896 is given the work done on this stream by the United States since the first independent appropriation of June 14, 1880.

Operations during the fiscal year 1897.—The U. S. snag boat *Sheldon* worked twice over the river from the mouth to Current River in the summer and autumn of 1896, very thoroughly clearing that part of the river of low-water obstructions. This boat again went over the river below Black Rock in June, 1897, removing obstructions of recent development. Only two places were in bad condition.

The upper river, between foot of Big Island and Poplar Bluff, while near low-water stage, was well worked by the U. S. snag boat *Riverside.* This boat also worked between Indian Ford and Big Island while the river was at medium stage. The operations not only removed obstructions of recent formation, but removed many of the older ones. The snagging operations of each boat are given in the tabulation below.

The U. S. snag boat *Sheldon* was sent from Black Rock on the 21st of June to tow the U. S. dredge *Van Frank* from the Arkansas River to Spring River Shoal. At the close of the month the steamer and tow were at Newport, Ark., on the return trip.

Snagging operations of Sheldon and Riverside.

Month.	Boat.	Snags removed.	Trees cut.	Drifts broken.	Between—
August	Sheldon	312	230	8	Mouth and Price Cut-off.
September	do	547	734	9	Price Cut-off and Julia Dean.
Do	Riverside	119	88		In Duck Roost (4 miles).
October	Sheldon	247	265		Julia Dean and Current River; Current River and mouth.
Do	Riverside	250	46		In Big Island Chute (9 miles).
November	do	124	39		Big Island Chute and Poplar Bluff. Poplar Bluff and into Chute.
December	do	128	75	16	Dan River and Schaffers Eddy.
January (3 days)	do	9	2		Schaffers Eddy and Indian Ford.
June	Sheldon	136	251	5	Mouth and Black Rock.
Total		1,872	1,730	38	

Channel and results of work.—Prior to any work by the United States, Pocahontas was considered the practical head of navigation, and navigation above that point was left to the very venturesome steamboat men. Rafting out of Upper Black was impossible, as a skiff could not make continuous passage from Poplar Bluff to the Missouri State line when the river was less than bank full. Now the river below Current can be navigated nearly all the time by boats of 3-foot draft, Julia Dean Bar and Spring River Shoal being the only points that limit this draft, and they interfere only at long intervals. During the fall low-water season of 1896, 3 feet was reported over these places, and 4½ feet in fall low water of 1895, but in May, 1895, steamboat men reported the river at 0.6 to 0.8 lower than ever known, at which time the available depth over Spring River Shoal was 2.3 feet and over Julia Dean Bar 2.8 feet. Out of Poplar Bluff small steamers towing barges of 2.5-foot and 3-foot draft now ply the stream for about ten months each year, and rafting from this part of the stream to Black Rock and Newport is carried on for about the same time. Much rafting is done above Current River; sunken saw logs and fallen timber rapidly fill the river and reduce the natural depths. These accumulations keep pace with the operations of the snag boats, and it is my opinion that snagging operations can be increased with profit. I estimate that $400 per mile will thoroughly snag the 123 miles of river above Current River, and that $8,000 will be required annually for maintaining a clear channel from White River to Poplar Bluff, 269 miles.

Money statement.

July 1, 1896, balance unexpended	$12,331.90
June 30, 1897, amount expended during fiscal year	7,127.06
July 1, 1897, balance unexpended	5,204.84
July 1, 1897, outstanding liabilities	900.00
July 1, 1897, balance available	4,304.84
Amount (estimated) required for work annually	8,000.00
Amount that can be profitably expended for maintenance in fiscal year ending June 30, 1899	8,000.00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Appropriations have been made for this river separately under the head of Improving Black River, Missouri, and Improving Black River, Arkansas and Missouri, and also in combination with other rivers. Of the distribution of the expenditures under the latter appropriations, I have no information to present. The appropriations for this river, separately, are as follows:

June 14, 1880	$15,000.00
March 3, 1881	6,000.00
August 2, 1882	10,000.00
July 5, 1884	20,000.00
August 5, 1886	5,000.00
August 11, 1888	5,000.00
August 11, 1888 *	7,000.00
September 19, 1890	5,000.00
September 19, 1890 *	7,000.00
July 13, 1892	5,000.00
August 17, 1894	9,500.00

June 3, 1896		$8,000.00
Total		102,500.00
Expended to June 30, 1896	$94,686.98	
Less sales and refundments	4,518.88	
		90,168.10
Unexpended July 1, 1896		12,331.90

COMMERCIAL STATISTICS.

The commerce of the portion of Black River above the mouth of Current River is that arising solely from lumber and stave industries. Saw logs, rough lumber, and staves are rafted or towed in barges to railroad points, and provisions and miscellaneous freights are taken thence to the timber and stave camps. Below the mouth of Current River plantation products and supplies, together with timber products, make up the commerce.

Below Current River the river is navigated all the year; above Current River it was navigated about ten months during the last year.

List of stern-wheel boats engaged in navigating Black River, Arkansas and Missouri, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Loaded draft.		Between—	Round trips.	Passengers.
		Steamer.	Barges.			
		Ft. In.	Ft. In.			
Moark	27.3	2 2	4 0	Poplar Bluff and Lake Slough	111	....
Louise	27.0	3 0	4 0	....do	158	....
				Poplar Bluff and Corning	12	....
Arthur	13.6	1 4	....	Poplar Bluff and Corolla	12	....
				Poplar Bluff and Lake Slough	37	....
				Poplar Bluff and Duck Roost	4	....
Black Diamond *a*	18.4	3 0	3 6	Black Rock and Current River	(?)	....
				Black Rock and Newport	(?)	....
				Black Rock and Upper Black River.	(?)	....
Portia	49.7	3 0	4 0	Towing to Black Rock	108	636
Krata	....	1 6	3 0	....do	86	470
G. M. Sivley *a*	98.9	5 0	5 0	(?)	(?)	....
Josie Sivley *a*	(?)	(?)	(?)	(?)	(?)	....
J. A. Woodson	219.8	3 6	....	Newport and Current River	49	460
A. R. Bragg	162.7	3 6	....	....do	3	25
Tycoon	64.5	3 0	3 6	Newport and (?)	(?)	(?)

a No report.

Classification of commerce reported.

Articles.	1897.		1896.	1895.	1894.
	Estimated value.	Tons.	Tons.	Tons.	Tons.
Cotton	$388,160	2,426	2,181	1,473	2,545
Cotton seed	10,552	1,319	980	6,320	1,524
Hides and skins	8,250	110	60	96	19
Livestock	500	125	62	57	59
Lumber	53,230	10,646	12,912	12,840	9,710
Staves and bolts	89,982	24,995	5,865	8,171	17,412
Provisions	864,640	5,404	1,010	2,694	632
Grain	1,940	194	738	495	372
Spokes	....	....	....	437	1,780
Saw logs	117,760	58,880	76,073	83,931	39,300
Railroad ties	12,609	4,670	7,134	13,441	12,375
Piling	....	....	2,400	400	....
Square timber	8,976	1,360	1,045	1,500	....
Miscellaneous	148,200	1,482	818	578	1,808
Total	1,704,799	111,611	111,278	132,438	87,536

*Not shown in previous statements.

V 5.

IMPROVEMENT OF CURRENT RIVER, ARKANSAS AND MISSOURI.

The appropriation of August 17, 1894, was based upon a report made to comply with the requirements of the river and harbor act of September 19, 1890. The report was printed in House Ex. Doc. No. 157, Fifty-first Congress, second session, and in Annual Report Chief of Engineers for 1891, pages 2065–2071.

Original condition.—Between the mouth and 2 miles below the State line snags and overhanging timber were the obstructions to navigation; above this point gravel shoals were added to the list.

Object.—To improve the navigation of the river from the mouth to Vanburen, Mo. (95 miles).

Project.—To remove logs and snags from channel; to cut and deaden overhanging timber, and to contract water width at worst shoals by wing dams.

Work done in previous years.—The first work by the United States on this stream was in 1873. On page 1689 of Annual Report for 1896 the work done since that time is shown.

Operations during fiscal year 1897.—July 10 to August 17: The hand-propelled snag boat *Riverside* worked over the river below Johnsons Landing. One hundred and thirty-seven snags were removed, 209 trees cut, and 2 drifts broken up. The *Riverside* was then sent to upper Black River and nothing more was done on this stream.

This appropriation pays one-third of the cost of rebuilding the *Riverside*, which work is reported under the head of "improvement of White River, Arkansas."

Channel.—From the mouth to Johnsons Landing (25 miles) the river can be navigated at all times by boats of 3½-foot draft. From Johnsons Landing to 11 miles above Doniphan a rafting channel was opened in fiscal year 1896, and a fair steamboat channel was also opened to near the Arkansas-Missouri State line. Since this stream was last worked, freshets have brought many new snags into the river and caused many trees to topple over the banks. From the mouth of the river to Little Black River there yet remains a fair steamboat channel, but from Little Black River to Current View the river is in bad condition. The U. S. snag boat *Sheldon* will go into the river early in the coming year and give such relief as the small balance will permit.

The approved project contemplated the improvement of this stream to Vanburen, Mo., a point 31 miles above the upper limit of work done under present appropriation. This project also contemplated the contraction of water widths at the worst shoals by wing dams. The money expended so far has been expended altogether in removing obstructions from the channel and in cutting overhanging timber. The appropriation of $2,000 in act of June 3, 1896, completes the amount originally estimated as necessary to complete the project. Every rise adds new obstructions to this stream, and it will require about $2,000 a year to maintain the channel already opened up.

Money statement.

July 1, 1896, balance unexpended	$3,644.31
June 30, 1897, amount expended during fiscal year	1,325.79
July 1, 1897, balance unexpended	2,318.52
July 1, 1897, outstanding liabilities	200.00
July 1, 1897, balance available	2,118.52

APPROPRIATIONS.

The early examinations of this river were made under appropriations for this in combination with other streams. The independent appropriations for this stream are as follows:

June 2, 1872, Current River, Missouri		$5,000.00
March 3, 1881, Current River, Arkansas and Missouri		2,000.00
August 17, 1894, Current River, Arkansas and Missouri		8,000.00
June 3, 1896, Current River, Arkansas and Missouri		2,000.00
Total		17,000.00
Expended to June 30, 1896	$13,357.69	
Less refundments	2.00	
Net expenditures to June 30, 1896		13,355.69
Unexpended July 1, 1896		3,644.31

COMMERCIAL STATISTICS.

For a number of years a weekly packet out of Newport, Ark., has plied this stream as far as Johnsons Landing. Towboats after timber and staves occasionally go from Newport to Little Black River. From Black Rock a stave boat makes frequent trips to the stave camps at Current View and below. Full reports of material transported have not been received in response to repeated inquiry.

List of stern-wheel boats that navigated Current River, Arkansas, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Loaded draft.		Between—	Round trips.	Passengers.
		Steamer.	Barges.			
		Ft. In.	*Ft. In.*			
A. R. Bragg	162.71	3 6	0 0	Newport and Johnsons	3	15
J. A. Woodson	219.8	3 0	0 0	do	49	225
G. M. Sivley *a*	98.9	5 0	5 0	Newport and (?)	(?)	
Josie Sivley *a*	(?)	(?)	(?)	Newport and (?)	(?)	
Black Diamond *a*	18.4	3 0	3 6	Black Rock and points below Current View.	(?)	

a No reports from these boats.

Classification of commerce reported.

Articles.	1897.		1896.	1895.
	Estimated value.	Tons.	Tons.	Tons.
Cotton	$97,600	610	719	875
Cotton seed	6,400	800	423	550
Lumber *a*	1,900	380	292	1,026
Staves and bolts *a*	3,312	920	1,375	4,225
Grain	200	20	330	175
Provisions	403,200	2,520	200	540
Saw logs *a*	20,140	10,070	23,730	13,479
Railroad ties *a*			1,667	8,333
Square timber	8,976	1,360	1,045	1,500
Miscellaneous freights	39,800	398	86	502
Total	581,528	17,078	29,867	31,205

a Full reports not received.

V 6.

IMPROVEMENT OF ST. FRANCIS RIVER, ARKANSAS.

Original condition.—Below Marked Tree snags, leaning trees, and shoals obstructed navigation. Above Marked Tree, through the Sunk Lands, the channel meandered through cypress brakes, beds of smartweed, and in many places the waters were divided by sloughs and chutes.

Object of improvement.—Originally to improve navigation below Lesters Landing (232 miles), later to extend improvement (73 miles) to the town of St. Francis, Ark., now to improve navigation between Kennett, Mo., and the mouth of the river (279 miles).

Project.—The usual snagging operations and closing of chutes and sloughs.

Work done in previous years.—Work done on this stream has been under the heads of improvement of White and St. Francis rivers and that of improving St. Francis River, Arkansas. Annual Report for 1896, page 1692, gives full statement of the snagging operations of previous years.

Operations during fiscal year 1897.—The hull of the U. S. snag boat *A. B. Johnson* (hand propelled) having become unserviceable, authority was obtained to rebuild the boat. This work began September 15, but owing to delays in lumber shipments it was the 4th of November before the hull was launched and December 15 before the boat was ready for snagging operations. Very little of the old boat could be used again, and, excepting the boiler and capstans, the *A. B. Johnson* is a new boat. By the time it was completed backwater from the Mississippi River was up to Quigley Bend. Snagging operations were begun here on December 19, and the river very thoroughly cleared of snags up to Madison (5½ miles). The boat was then floated to Burnt Cane Bend, from which point the timber was cut on the caving banks up to Madison (20 miles). The boat was laid up at Madison January 31, 1897, the river then being at 8 feet on the Madison gauge. One hundred and five snags were removed, 2,868 trees cut, and 4 drift piles broken up.

The river and harbor act of 1896 provided for a survey of the St. Francis River and the submission of plans and estimates for the improvement of this river by locks and dams to give slack-water navigation from its mouth to Wittsburg, and to Marianna, on L'Anguille River, its tributary.

It was my intention to quarter the surveying party on the hand snag boat *A. B. Johnson*, and run levels from Madison to the mouth of St. Francis; make detailed survey of the bar at the mouth and other bars between there and L'Anguille River; to run a side line of levels up the L'Anguille River to Marianna and finally connect Madison and Wittsburg. The rebuilding of the *A. B. Johnson* progressed so slowly that this plan could not be followed, but, instead, low-water marks at Wittsburg, Madison, and Marianna were connected by a duplicate line of Wye levels that followed the railways and highways connecting these towns. From Marianna the line of levels was carried to the mouth of L'Anguille River and the work suspended, as the St. Francis River was at 10 or 12 foot stage and rising, this preventing accurate determination of low-water elevations and the character of foundations at possible lock locations. The levels are to be continued to the mouth of the St. Francis River when low-water season arrives, which is generally in September and October.

The field expenditures incurred by the rebuilding of the *A. B. Johnson* are given in the abstract below:

	Hull.	Cabin.
Lumber	$282.10	$74.86
Oakum (7 bales)	24.25	
Calking cotton (50 pounds)	3.75	
Paints and oils	11.14	33.04
Spikes and nails	23.10	4.50
Iron and bolts	36.16	
Doors, lock and sash		8.71
Roof canvas and tacks		20.03
Roof ventilators and caps		6.40
Labor, supervision, and subsistence	1,137.36	642.48
Total	1,517.86	790.02

Total cost of rebuilding, $2,307.88.

Channel.—I have been unable to inspect this stream. Steamboat men report considerable improvement below Wittsburg and through some of the reaches in the Sunk Lands. Between Marked Tree and Little River it is reported as filling rapidly with sunken logs and fallen timber.

Money statement.

July 1, 1896, balance unexpended	$8,342.89
June 30, 1897, amount expended during fiscal year	5,125.00
July 1, 1897, balance unexpended	3,217.89
July 1, 1897, outstanding liabilities	125.00
July 1, 1897, balance available	3,092.89
Amount (estimated) required for work annually	8,000.00
Amount that can be profitably expended for maintenance in fiscal year ending June 30, 1899	8,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

The earlier examinations and the earlier operations were made under appropriations for this in conjunction with other rivers. Of the expenditures under these appropriations this office has no record.

The separate appropriations are as follows:

March 3, 1871		$10,000.00
June 14, 1880		5,000.00
July 5, 1884		12,000.00
August 5, 1886		8,000.00
August 11, 1888		4,000.00
September 19, 1890		4,000.00
August 17, 1894		*83,000.00
June 3, 1896		8,000.00
Total		134,000.00
Expended to June 30, 1896	$50,657.27	
Less refundment	.16	
Net expenditures to June 30, 1896		50,657.11
Unexpended July 1, 1896		8,342.89

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* Seventy-five thousand dollars of this, by the conditions of the act, to be expended by the Mississippi River Commission.

COMMERCIAL STATISTICS.

As in previous years, timber and cooperage stuffs make up the greater part of the commerce reported. While there is an increase in the quantity of plantation products transported, full report has not been received as to that class of commerce.

The river between Bertig and Marked Tree was navigable for six months, between Marked Tree and Madison, seven months, and below Madison for nine months.

List of stern-wheel boats engaged in navigating St. Francis River, Arkansas, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Loaded draft.		Between—	Round trips.
		Steamer.	Barges.		
		Ft. In.	*Ft. In.*		
Rosa	50.3	2 6	3 0	Helena and Marked Tree	40
Emma No. 2	28	2 4	3 0		
Fletcher	8.2	2 0	2 0	Madison and cut-off Madison and Wittsburg	4 4
Grace Velie	53	3 6	3 6	Helena and ?	60
Maude	101	4 0	....	Helena and ?	42
Edwin	13.6	1 0	3 0	Marked Tree and Little River.	25
Tom Young	18.6	2 4	3 0	Marked Tree and Lake City	10
Louis Houck	620.5	6 5	6 6	St. Louis, Mo., and points below Black Fish Cut-off.	8
Henrietta	99	4 0	4 0	Helena and ?	(?)
Delta	35	2 0	3 0	Bertig and Lake City	50
Jim *a*	13	2 6	2 6	Bertig and Marked Tree	25
Ike	66.2	2 0	2 6	Twedell and Marked Tree	25
Clarence E. Long	13	2 6	3 0	Marked Tree and Mitchells	50
Zip McCoy	146	3 0	....	Helena and ?	2
L. E. Patton	92	3 6	6 0	Memphis and ?	(?)
Ora Lee	189.3	5 0	....	Memphis and points below Madison	(?)
Memphis	110.8	4 6	4 6	Memphis and Tyronza River	1

a Gasoline boat.

The steamer *Rosa* began navigating this stream in December, 1896; the *Fletcher* in April, 1897, and *Jim* in February, 1897.

Classification of commerce reported.

Articles.	1897.		1896.	1895.	1894.
	Estimated value.	Tons.	Tons.	Tons.	Tons.
Cotton	$278,400	1,740	575	382	125
Cotton seed	40,168	5,021	731	1,172	60
Hides	1,500	20	3	10	2
Live stock	102,800	2,570	300	61	45
Provisions	405,600	2,535	751	271	52
Grain	16,500	1,650	280	734	43
Railroad ties	270	100	1,670	....	....
Saw logs	116,660	58,830	*a* 51,700	22,000	12,000
Staves	52,243	14,512	5,934	7,869	5,860
Lumber	51,750	10,350	5,690	4,585	1,575
Miscellaneous	52,000	520	106	1,023	1
Total	1,117,891	97,848	67,740	38,107	19,763

a Corrected by adding material reported after report of 1896 was made.

V 7.

IMPROVEMENT OF ST. FRANCIS RIVER, MISSOURI.

The first appropriation under this head was based upon report of an examination made to comply with the requirements of river and harbor act, August 5, 1889. This report is printed in the Annual Report of the Chief of Engineers for 1887, page 1549.

Original condition.—Channel obstructed by snags, drifts, drift shoals, and overhanging timber; in the upper reaches by gravel shoals.

Object of improvement.—Originally to improve navigation between the towns of St. Francis, Ark., and Greenville, Mo. (102 miles); later to include the river from St. Francis, Ark., down to Kennett, Mo. (26 miles), in this improvement.

Project.—The usual snagging operations.

Work done in previous years.—Although the original estimate and the basis for the first appropriation contemplated removal of gravel from the shoals lying within 12 miles of Greenville, this work was never included in the projects for expending the various appropriations, thus leaving snagging operations as the work of past years.

Operations during fiscal year 1897.—The U. S. snag boat *Missouri* (hand propelled) worked over the river from head of Whittaker Cut-off to Freeman Place. The boat turned back at the Freeman Place on September 7 and reached St. Francis September 19. Between these dates the river was at 0.6-foot stage, and the boat found 21 shoals on which there were between 12 and 24 inches of water. In July, when the river was at 4-foot stage, only 18 inches was found in the channel through Beasly Cut-off. The main river carries plenty of water and the boat worked that. Steamboats use the cut-off when the river is at 8-foot stage or over. At Dalton Race the head of the old river was dry at 3.3-foot stage. Four hundred and sixty-one snags were removed and 228 leaning trees cut in the 20 miles of river worked.

Since September 19 the *Missouri* has been laid up at St. Francis in the care of a watchman.

Channel.—I have not had funds or plant available for inspecting this stream. Steamboatmen and raftmen report a great improvement, but that the channel is filling again with sunken logs and fallen timber. There is considerable rafting on this stream and the accumulation of sunken logs has kept pace with the snagging operations.

Plant.—This appropriation owns no plant. The U. S. snag boat *Missouri*, owned by appropriation for improving Arkansas River, Arkansas, has been used on this stream. It is now unserviceable. The appropriation for improving St. Francis River, Missouri, being exhausted, the boat is being cared for out of the appropriation owning it.

Money statement.

July 1, 1896, balance unexpended	$2,218.88
June 30, 1897, amount expended during fiscal year	2,158.35
July 1, 1897, balance unexpended	60.53
July 1, 1897, outstanding liabilities	60.53

APPROPRIATIONS.

This reach of river is understood not to have been included in the snagging operations under the early appropriations for snagging in Western rivers.

Its specific appropriations are as follows:

August 11, 1888		$5,000.00
September 19, 1890		10,500.00
August 17, 1894		5,000.00
Total		20,500.00
Expended to June 30, 1896	$21,281.12	
Less sales	3,000.00	
Net expenditures to June 30, 1896		18,281.12
Unexpended July 1, 1896		2,218.88

COMMERCIAL STATISTICS.

The commerce of this river is that arising solely from lumber and stave industries. The tonnage reported this year is about two-thirds of that of the preceding year. This may be partly due to the destruction by fire of one of the largest stave and lumber plants on the river and partly because full report of rafted material has not been received.

The river was reported navigable above Chalk Bluff for seven months during the year ending May 31, 1897.

List of stern-wheel boats engaged in navigating St. Francis River, Missouri, May 31, 1896, to June 1, 1897.

Name.	Tonnage.	Loaded draft.		Between—	Round trips.
		Steamer.	Barges.		
		Ft. In.	*Ft. In.*		
Roy	24.6	1 8	3 0	Towing to Poplin	78
S. A. Stroud	35.3	2 6	3 6	St. Francis and Browns Ferry	90
				St. Francis and Reddles Ford	28
				St. Francis and Poplar Creek	12
Milt Janes	25.5	2 7	3 0	St. Francis and Big Drift	38
				Towing to Poplin	81
				St. Francis and Varner River	33

Classification of commerce reported.

Articles.	1897.		1896.	1895.	1894.
	Estimated value.	Tons.	Tons.	Tons.	Tons.
Lumber	$9,150	1,830	700	3,100	3,402
Staves and bolts	27,170	7,547	9,660	7,106	20,275
Provisions	1,600	10	....	50	6
Grain	450	45	....	11	180
Miscellaneous freights	4,900	49	....	59	160
Spokes	....	....	2,100	....	1,901
Saw logs	23,428	11,714	a17,400	12,000	9,882
Piling	5,098	927	a4,762	....	....
Square timber	726	110	....	....	....
Railroad ties	2,899	1,074	a875	....	....
Total	75,421	23,306	35,497	22,326	35,806

a Corrected by adding material reported too late for incorporation in Annual Report for 1896.

This river is crossed near Wappapello by the Cape Girardeau and Fort Smith Railway, at Poplin by the Poplar Bluff and Cairo Branch of the St. Louis, Iron Mountain and Southern Railway, and at St. Francis by the St. Louis Southwestern Railway.

V 8.

PRELIMINARY EXAMINATION OF NEOSHO RIVER, KANSAS, FROM THE NORTH LINE OF NEOSHO COUNTY TO THE SOUTH LINE OF LABETTE COUNTY.

[Printed in House Doc. No. 83, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated November 24, 1896, by Capt. William L. Sibert, Corps of Engineers, upon preliminary examination of Neosho River, Kansas, "from the north line of Neosho County to the south line of Labette County, with a view to straightening and otherwise improving the channel of said river," made to comply with provisions of the river and harbor act of June 3, 1896.

Captain Sibert states that the extremely small low-water discharge makes it impracticable to improve this stream for navigation purposes, and therefore, in his opinion, the river is not worthy of improvement by the United States. The views of the district officer are concurred in by the division engineer, Colonel Barlow, and by me.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., November 24, 1896.

GENERAL: In accordance with directions contained in letter from your office dated June 16, 1896, I have the honour to submit the following report concerning the preliminary examination of Neosho River, Kansas, from the north line of Neosho County to the south line of Labette County, with a view to straightening and otherwise improving the channel.

This preliminary examination was made under my direction by United States Assistant Engineer J. R. Van Frank, whose report is inclosed herewith, and to which attention is respectfully called for all the details of the examination.

The portion of the river examined is about 98 miles long; it has an average width of about 200 feet at low water; a discharge at low water of about 60 cubic feet per second; an estimated discharge at high water of about 18,000 cubic feet per second; an average height of banks of about 22 feet; an average fall per mile of about 1.25 feet; a difference between high and low water of about 24 feet.

There are three milldams and nineteen railroad and county bridges along this reach of river, which would obstruct navigation were it otherwise practicable.

The extremely small low-water discharge makes it impracticable to improve this stream for navigation purposes. It is not, therefore, in my opinion, worthy of improvement by the United States.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
Washington, D. C., November 30, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

The conclusion of the district engineer that this locality is not worthy of improvement by the General Government is concurred in.

J. W. BARLOW,
Colonel, Corps of Engineers,
Division Engineer, Southwest Division.

REPORT OF MR. J. R. VAN FRANK, ASSISTANT ENGINEER.

LITTLE ROCK, ARK., *October 19, 1896.*

SIR: I have the honor to report upon the examination of Neosho River, Kansas, as follows:

This river rises in east central Kansas, flowing in a southeasterly direction through Morris, Chase, Lyon, Coffee, Woodson, Allen, Neosho, Labette, and Cherokee counties, an approximate distance of 300 miles, and has a watershed of about 6,000 square miles.

The portion of the river that I examined with a view to navigation, commencing at the north line of Neosho County, running in a southeasterly direction through Neosho and Labette counties, has a length of 98 miles, an average width of 200 feet between banks 22 feet high, and at the present low-water stage has a depth of 6 inches over the shoals, from 3 to 10 feet in the pools, and has an oscillation of 24 feet.

The general character of the river is winding through an alluvial bottom from 1 to 3 miles in width, overflowing its banks at the highest rises and inundating the farming land in the bottoms on either side.

During the rainy seasons the water will rise to bank full and, overflowing in twenty-four hours, will continue full for three days, then recede almost as rapidly as it came up. The velocity of these freshets is from 3 to 5 miles per hour.

The ordinary stage of water is from 2 to 3 feet above extreme low water; this would give about 1½ to 2 feet of water over the shoals. What the velocity would be at this stage is difficult to determine without an actual observation. However, there would be a perceptible current throughout the entire length of the stream.

At the present low-water stage, which has extended through July, August, September, and October, there is no perceptible current except over the shoals. These shoals are generally limestone ledges extending entirely across the river, and are from one-eighth to one-half mile in length. Some of these shoals are gravel reefs washed up from a sharp bend, bridge abutment, or milldam, and some of them are 6 feet high above low water and extend nearly across the bed of the river, leaving only a narrow space on one or both sides for the passage of low and medium stages of water. At low water some of these passages are only 30 feet wide and 6 inches deep, with an estimated discharge of 60 cubic feet per second. The pools above and below the shoals have no current at low water, and range from 3 to 10 feet deep and from 100 to 200 feet wide on the surface.

The probable fall of this stream is 1.25 feet per mile, with a maximum high-water velocity of 5 miles per hour and a maximum discharge of 18,000 cubic feet per second.

There are three milldams, nineteen railroad and wagon bridges, and numerous fording places along this reach of river. The milldams are constructed of rock and timber, and range from 4 to 10 feet high. One of them cost $50,000.

Some of the bridges have single spans over the main river from 150 to 250 feet in length, with approach spans or piling, and others have double spans from 100 to 140 feet each, with a rock pier in the middle of the stream. These middle piers have formed gravel reefs below them, some one-fourth of a mile long, thus dividing the channel. The general height of these bridges is from 25 to 30 feet above low-water and from 1 to 6 feet above high-water line. All of them contract the high-water flow to such an extent as to become an obstruction.

A detailed description of each bridge and dam is given below in rotation from the State line up:

First. Milldam located 3 miles below Chetopa, in Cherokee County, constructed of brush and loose rock, 4 feet high, 400 feet across the main bed of river; water above dam is 2 feet plus water below dam; shoals (rock bottom) for 800 feet below the dam, water 6 inches deep.

Second. Wagon bridge at Chetopa has one single iron span 255 feet over main channel, with an approach span of 85 feet; lower chord 25 feet above low water. River oscillation about 20 feet.

Third. Missouri Pacific Railway Bridge at Chetopa: 180-foot iron truss span; 60-foot iron girder span, 200 feet piling; total waterway 440 feet. Lower chord 24 feet above low water. River oscillation 20 feet.

Fourth and fifth. Two bridges 1 mile east of Oswego, one the duplicate of the other, the railway bridge 100 feet above the wagon bridge, as follows: St. Louis and San Francisco Railroad Bridge: Two spans, 100 feet each, stone abutments and middle pier. Thirty feet above low water. River oscillation 28 feet. Width of bottom land 1½ miles.

Sixth. Wagon bridge north of Oswego: Two spans, iron truss, 110 feet each, middle stone pier, 300 yards of high waterway, 6 feet deep at end of bridge. Oscillation 24 feet.

Débris of milldam under this bridge.

Seventh. Milldam under bridge, 4 feet high. This is a wreck of what was once a dam; the mill burned down, and the dam is partially torn down by people who are opposed to it as a water obstruction. The low waterway through the old race is 30 feet wide and 6 inches deep, and has a discharge of about 60 cubic feet per second. The original dam, located 200 yards above, still stands and is 4 feet higher, making a fall of 8 feet altogether.

Eighth. Missouri, Kansas and Texas Railway Bridge, Mineral branch: One span, 170 feet; also 300-foot trestle. Shoals under this bridge. Water one-half foot deep, rock bottom. Bottom land 1¼ miles wide.

Ninth. Montana wagon bridge: One span 210 feet, and 100-foot approach span. Lower chord 35 feet above low water.

Tenth. Kansas City, Pittsburg and Gulf Railroad Bridge, 8 miles east of Parsons, in the northern part of Labette County; one single span, 160 feet over main channel; approach span 100 feet, west side; approach span 50 feet, east side. Base of rail about 30 feet above low water. Bank about 22 feet above low water. Shoal under bridge; water 6 inches deep; rock bottom; extends one-fourth mile below bridge.

Eleventh. Wagon bridge, 200 yards above the railroad bridge; single span, 225 feet; approaches 100 feet at each end. Roadway 10 feet higher than banks and about 32 feet above low water. Caisson piers; shoal under bridge. Bottom land one-half mile wide on east and three-fourths mile on west; overflow from 1 to 2 feet deep.

These are all of the bridges in Labette County. The next bridge across the main stream is about 16 miles farther north, in Neosho County. Although there is a wagon bridge across a bayou, or high-water chute, of this river about 10 miles north, there is no further note of it in this report.

Twelfth. Wagon bridge, 2 miles south of St. Paul; single span 180 feet; stone abutments, combination wood and iron truss, 30 feet above low water, 7 feet above natural surface of bank. High-water line 2 feet over bank.

Thirteenth. Missouri, Kansas and Texas Railway Bridge, 1 mile south of St. Paul; single span, 160 feet over main channel.

Fourteenth. Wagon bridge, 2 miles southwest of St. Paul; two iron truss spans 140 feet each; middle pier rock; end pier caissons; 27.5 feet high; 5 feet above bank. Oscillation 25 feet. Shoal under bridge one-fourth mile long, water 6 inches deep. Towhead formed below middle pier one-fourth mile long.

Shoal and ford, surface of low water, 150 feet wide, 6 inches deep, one-fourth mile long, gravel bar located one-half mile north of the above bridge.

Shoal and ford 1 mile farther north; gravel bar 6 feet high, extending almost across the main bed of river, with narrow channel for low water 20 feet wide; riffle 40 feet wide, 6 inches deep, and 100 feet long; discharge about 60 cubic feet per second.

Fifteenth. Missouri, Kansas and Texas Railway Bridge (Kansas City branch); single span 150 feet over main over channel; also 150-foot pile approach. Base of rail 28 feet above low water and 8 feet above top of banks or high water of 1892. Area of cross section high water, 1892, 5,375 square feet. Area of railroad dump obstruction to high water of 1892 on north side, 2,502 square feet. High water 1895, 6.4 feet below base of rail. High water 1885, 6 feet below base of rail (highest water known). Oscillation 22 feet.

Sixteenth. Wagon bridge at Erie Milldam; one span 180 feet across main channel; one approach span 75 feet. Top of bridge pier 20 feet above present low water in pond above the dam; water in pond about 9 feet deep. High water, 1885, is 4.2 feet below top of pier.

Seventeenth. Erie Milldam, 150 feet below bridge. This dam is a wooden structure with rock abutments at ends; height of dam 10 feet above bed rock or natural shoal of stream; present low water in pond 2 feet below top of dam, about 7 feet difference in water above and below the dam. Approximate cost of milling plant $50,000.

This dam backs water 8 miles upstream, covers one shoal in the distance, and heads at a solid rock shoal.

Eighteenth. Shaw wagon bridge; combination wood and iron truss, caisson piers; span 150 feet over main channel; 50-foot approach on east; 75-foot approach on west. Low water 29 feet below lower chord. High water, 1885, 2.9 feet below lower chord. Oscillation 26 feet. Pool under bridge 12 feet deep.

Nineteenth. Austin Milldam, 10 feet high, constructed of rock (dry masonry) on a solid rock shoal with projecting ledges one side, originally a narrow place in the stream on account of this rock ledge and shoal. Approximate cost of plant, $50,000. Shoal for one-half mile below dam; average depth less than 1 foot.

Twentieth. Santa Fe Railway Bridge, southeast of Chanute; span 200 feet, iron truss, with approaches. Low water 24 feet below lower chord. Roadbed about 10 feet above natural surface of bank. Water 8 feet deep under bridge, backwater from milldam.

Twenty-first. Wagon bridge, east of Chanute; span 160 feet, iron, with approaches amounting to 344 feet waterway. Low water 29 feet below lower chord. Hihg water, 1885, 5.5 feet below lower chord. Roadbed about 10 feet above natural surface of bank. Pool under bridge 7 feet deep. Waterworks of Chanute located here.

Twenty-second. Santa Fe Railway Bridge, north of Chanute; one span 200 feet; pile approach at each end, making total length of bridge opening 315 feet. Lower chord 31 feet above low water. Oscillation, 1885, 26 feet.

Twenty-third. Wagon bridge, north of Chanute; main span 150 feet, with 50-foot approach at each end. Same reference to water lines as the above railway bridge.

These bridges are near each other; also near the north line of Neosho County.

Length of Neosho River, in Neosho County, as taken from Government land plats, is 65 miles. About 50 miles of levees from 4 to 6 feet high have been built along this reach of river to protect farming lands from overflow. It has been estimated that 60 miles more would complete this levee system and give ample protection to all the overflow lands in Neosho County.

The general sentiment of the people as to improvement of the river is for the protection of the farming lands from overflow.

There is no steamboat navigation on this stream and not sufficient water for any length of time to make navigation practicable.

There are competing lines of railroads across the counties east, west, north, and south, giving ample facilities for transportation to the country. Therefore I recommend no improvement for navigation.

Labette County has no public levee system, although private levees from 12 inches to 18 inches high have been constructed at various points along the river bank for the protection of crops.

The lands through these counties are practically all under cultivation and adapted to raising grain and grass. The acreage for each county will average about as the following list for Labette County:

LABETTE COUNTY, KANS.

Number of acres sown in grain for the years of 1893 to 1895, including spring of 1896.

[Taken from assessor's books by J. F. Thompson, county clerk; prepared for Busby & Smith, grain dealers, Parsons, Kans., May 29, 1896.]

Year.	Wheat.	Rye.	Corn.	Oats.	Flax.
1893	57,537	537	43,207	30,667	2,088
1894	51,004	306	48,113	33,459	2,988
1895	62,895	479	55,114	44,155	6,349
1896	50,729	169	60,556	37,378	4,411

Table showing total number of bushels of grain raised in year 1895.

Grain.	Acres.	Yield per acre.	Total yield.
		Bushels.	*Bushels.*
Wheat	62,895	14	880,530
Rye	479	10	4,790
Corn	55,114	32	1,763,648
Oats	44,155	35	1,545,425
Flax	6,349	6	38,094

Total 168,982 acres cultivated; 4,232,487 bushels of grain raised.

Area of Labette County, 400,000 acres.

Besides the above, I would approximately estimate an annual production of 15,000,000 pounds of beef and pork in Labette County and about the same for Neosho County.

Respectfully submitted.

J. R. VAN FRANK, *Assistant Engineer.*

Capt. WM. L. SIBERT,
Corps of Engineers, U. S. A.

V 9.

SURVEYS OF ARKANSAS RIVER AT LITTLE ROCK, VANBUREN, AND FORT SMITH, ARKANSAS.

[Printed in House Doc. No. 24, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 8, 1897.

SIR: The river and harbor act of June 3, 1896, provides, in the item of appropriation for improving Arkansas River, Arkansas and Indian Territory, that the Secretary of War, in his discretion, "cause examinations and surveys to be made at or near * * * Little Rock, * * * Vanburen, and Fort Smith, to determine whether or not, by reason of dikes or other Government works, any part of the harbors or river banks in their vicinity have been so injured or endangered that the Government should guard against or remedy the same; and for the purpose of making such surveys and works as may be found necessary to remedy and guard against such injury, the Secretary of War is authorized to set apart and use, in his discretion, a sufficient amount of this appropriation," and I now have the honor to submit the accompanying copy of report, dated March 10, 1897, by Capt. William L. Sibert, Corps of Engineers, concerning the examinations and surveys thus provided for.

Captain Sibert states that the Government works in the vicinity of Fort Smith have not so injured the harbor or river banks there that the Government should guard against or remedy the same, and that the filling up of the harbor and the caving of the banks at Vanburen and the caving of the bank in the vicinity of Little Rock are due to natural agencies and not caused by the Government works at those places. For the reasons given he is of the opinion that further surveys at the three localities mentioned are not necessary.

The views and recommendations of Captain Sibert are concurred in by the division engineer, Col. J. W. Barlow, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., March 10, 1897.

GENERAL: I have the honor to submit the following report concerning surveys called for in river and harbor act, June 3, 1896, at Fort Smith, Vanburen, and Little Rock.

On August 28, 1896, a report, with map, was submitted concerning a caving bank at Fort Smith, Ark. This report was called for by indorsement on letter from S. A. Williams, secretary Commercial League, Fort Smith, Ark., and was the result of a survey made at that time with a view to determining whether or not, by reason of dikes or other Government works, any part of the harbor or river banks in the vicinity had been so injured or endangered that the Government should guard against or remedy the same.

The report referred to above, together with report on survey submitted April 22, 1895, on the same question, gives all the data in the case.

It is the opinion of this office that the Government works in the vicinity of Fort Smith have not so injured the harbor or river banks in that locality that the Government should guard against or remedy the same; also that no further survey is necessary.

An examination has been made in the vicinity of Vanburen Ark. (a blue print of a map* showing locality when dikes were constructed is inclosed). From this examination the conclusion is reached that dikes at A could in no way be considered the cause of the filling up of the harbor on opposite side of river or the caving of the bank on same side at B. If the dikes in question had had any effect whatever, that effect would have been to prevent the filling up of the harbor and the caving of the bank at B. The caving of the bend above D caused the rock point at D to deflect the water more and more toward the south side of the river at A and below, and to overcome the effect of the dikes.

It is the opinion of this office that no further survey is necessary, and that the filling up of the harbor and the caving of the bank at B are due to natural causes.

On March 3, 1896, and on May 5, 1896, were submitted to you reports, with maps, concerning the claim that the caving of a certain bank about 5 miles below Little Rock, Ark., in the vicinity of Old Fourche, was due to the construction of certain dikes just below Little Rock, Ark., by the United States.

The conclusion reached in these reports was that the caving was due to natural causes, and that the construction of the dikes referred to had nothing to do with it.

This office has no knowledge of any other place in the vicinity of Little Rock where it has been claimed that damage has been done the harbor or river banks by dikes or other Government works.

This office is, therefore, of the opinion that all the data that would be obtained by survey in the vicinity of Little Rock have been submitted, and that no further survey is necessary.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

V 10.

SURVEY OF ARKANSAS RIVER AT PINEBLUFF, ARKANSAS.

[Printed in House Doc. No. 294, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 12, 1897.

SIR: The river and harbor act of June 3, 1896, provides, in the item of appropriation for improving Arkansas River, Arkansas and Indian Territory, that the Secretary of War may, in his discretion—

> cause examinations and surveys to be made at or near Pinebluff * * * to determine whether or not, by reason of dikes or other Government works, any part of

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* Not printed.

the harbors or river banks in their vicinity have been so injured or endangered that the Government should guard against or remedy the same; and for the purpose of making such surveys and works as may be found necessary to remedy and guard against such injury, the Secretary of War is authorized to set apart and use, in his discretion, a sufficient amount of this appropriation.

The duty of making the survey thus provided for was assigned to the charge of Capt. William L. Sibert, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, dated February 8, 1897, upon the subject.

It is the opinion of Captain Sibert that the dikes and bank protection at Pinebluff have not injured the river banks or harbor, but that such work has preserved the city from destruction. He states that the work below Dike No. 2 should be kept in repair, so that it will form a part of a complete system of regulation works; and such work has been authorized, funds being available for the purpose.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

HON. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., February 8, 1897.

SIR: I have the honor to forward herewith blue print* of survey made in vicinity of Pinebluff, with a view to determining whether or not, by reason of dikes or other Government works, any part of the harbor or river banks in the vicinity of Pinebluff has been so injured or endangered that the Government should guard against or remedy the same. This map shows six dikes, also bank protection from dikes 4 to 6 and from Mallory's ditch to "O." Dike 1 was made of brush and sand boxes for the first 400 feet. The remainder of the dike was made of piles with brush wattling. Dikes 2, 3, 4, 5, and 6 were made of brush and sand boxes, and after settling were capped with stone.

All of this work was done especially for the protection of the city of Pinebluff, and none of the work can, in my opinion, be charged with injuring the river banks or harbor. Its existence has, on the contrary, preserved the city from destruction.

There has been expended for the protection of Pinebluff by the United States since 1880 approximately $258,600. The total appropriation for improving the entire Arkansas River for this time was $1,133,500.

The principal part of the city of Pinebluff lies below Dike No. 2.

In my opinion the work below Dike No. 2 should be kept in repair, so that it will form a part of a complete system of regulation works.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

CHIEF OF ENGINEERS, U. S. A.

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* Not printed.

V 11.

SURVEY OF WHITE RIVER FROM BATESVILLE TO BUFFALO SHOALS, ARKANSAS.

[Printed in House Doc. No. 78, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of November 28, 1896, by Capt. William L. Sibert, Corps of Engineers, on the subject of survey of White River, Arkansas, between Batesville and Buffalo Shoals, with a view to improvement by slack-water navigation, made to comply with requirements of the river and harbor act of June 3, 1896.

Captain Sibert remarks that a former survey of the river, made in 1887, gives all the necessary data for preparing an estimate of cost with reasonable accuracy, and he states that the difference of elevation between Batesville and Buffalo Shoals (145.3 feet) can be overcome by ten locks, which will cost, with the necessary dams, $1,600,000.

This estimate is based on the supposition that there will be funds available sufficient to construct a lock and dam complete each working season when work is once commenced.

A profile of the river between Batesville and Buffalo Shoals, showing approximate location of locks, is submitted herewith.*

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., November 28, 1896.

GENERAL: In compliance with instructions contained in letter from your office dated September 5, 1896, I have the honor to submit the following report concerning a survey with estimate for improving White River from Batesville to Buffalo Shoals, Arkansas, by slack-water navigation.

An instrumental survey, including the portion of river under consideration, was completed under the direction of Capt. H. S. Taber, Corps of Engineers, in 1887, and a report submitted, printed in Annual Report, Chief of Engineers, 1888, page 1406.

This survey gives all the data for making an estimate with reasonable accuracy. Local surveys for the exact location of locks will be necessary when the work of improvement commences. These surveys can then be made with very little cost. Enough, however, is known from the survey to determine the general character of foundations to be expected and to make an average foundation cost.

The majority of the locks will have a rock foundation, the remainder gravel.

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*Not reprinted. Printed in House Doc. No. 78, Fifty-fourth Congress, second session.

In view of the above no survey has been made.

The survey previously made furnishes the following data:

Distance from Batesville to Buffalo Shoals, 88.75 miles; average fall per mile, 1.64 feet; low-water discharge, about 1,300 cubic feet per second; height of banks above low water for bottom lands, about 30 feet; material in shoals, gravel, bowlders, and solid rock; nature of banks, in general case permanent; rock and timber plentiful and convenient; high-water discharge not known; rises sudden and of short duration; difference between high and low water marks, about 32 feet; average width of stream at low water, about 600 feet.

PROJECT AND ESTIMATE.

It is proposed to make slack-water navigation in this stream by means of masonry locks and fixed dams.

LOCKS.

The lock proposed is to be of concrete masonry, 36 feet wide, 160 feet long between hollow quoins, with a depth of 4 feet on lower miter sill, lift about 14 feet, guard wall about 10 feet high, the design to be similar to locks of this size in successful use in the Engineer Department.

DAM.

The dam proposed is to be of timber cribs filled with stone; design to be similar to dams in general use in the Engineer Department.

ESTIMATE.

LOCK AND DAM COMPLETE.

Cofferdam, excavation, and foundation	$16,064
Concrete in lock proper, 7,717 cubic yards, at $9	60,453
Lock gates	4,283
Guide cribs	10,000
Lock houses, grading, and fencing	12,200
Dam complete	42,000
Abutment	5,000
Contingencies	10,000
Total	160,000

The difference in elevation between Batesville and Buffalo Shoals is 145.3 feet. Ten locks will be necessary to overcome this difference of level, at a cost of $160,000 for each lock and dam complete.

Total estimate for providing slack-water navigation from Batesville to Buffalo Shoals, $1,600,000.

This estimate is based on the supposition that there will be funds sufficient available to construct a lock and dam complete each working season, after work is once commenced.

A tracing of a profile of the river from Batesville to Buffalo Shoals, with the approximate location of locks, is forwarded herewith. On this map no allowance is made for the gain in elevation of water surface due to the slope in the pools.

In my opinion the river is worthy of the proposed improvement, and that the same is justified by the commerce that will be developed. That portion of Arkansas bordering on Upper White River is rich in manganese and zinc ores and marble, in addition to the lumber and agricultural interests, and has no outlet.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

V 12.

SURVEY OF BUFFALO FORK OF WHITE RIVER, ARKANSAS, FROM ITS MOUTH TO MOUTH OF RUSH CREEK, WITH A VIEW TO DETERMINE WHAT CHARACTER AND EXTENT OF IMPROVEMENT IS REQUIRED

[Printed in House Doc. No. 207, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 9, 1897, with map,* by Capt. W. L. Sibert, Corps of Engineers, of the results of a survey of Buffalo Fork of White River, Arkansas, from mouth to mouth of Rush Creek, with a view to determine what character and extent of improvement is required, made to comply with the provisions of the river and harbor act of June 3, 1896.

Captain Sibert states that a navigable depth in Buffalo Fork at all stages of water can be obtained only by means of locks and fixed dams, and that this method of improvement is only practicable by assuming that the dams will not leak. At least five locks and dams would be required to overcome the difference in level between the mouth of Buffalo Fork and the mouth of Rush Creek, and their cost is estimated at $750,000. In his opinion the commerce that would be developed by such improvement would not justify this expenditure.

He states that there is a plentiful supply of timber along the stream and rich deposits of zinc ore in the vicinity of the mouth of Rush Creek, and these two sources of commerce make the stream, in his opinion, worthy of improvement by the General Government to the following extent, at an estimated cost of $3,500:

To cut the overhanging timber and remove from the shoals the loose and solid rock that project above the general plane of the bed of the shoals, from the mouth to the mouth of Rush Creek.

The views of the local engineer are concurred in by Col. J. W. Barlow, Corps of Engineers, the division engineer.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 207, Fifty-fourth Congress, second session.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., January 9, 1897.

GENERAL: In accordance with requirements contained in letter from your office dated September 5, 1896, I have the honor to submit the following report on survey of Buffalo Fork of White River, from mouth to mouth of Rush Creek, with a view to determine what character and extent of improvement is required:

This survey was made by United States Assistant Engineer William Parkin, whose report is inclosed herewith, and to which attention is respectfully invited for detailed information concerning the stream in question.

A tracing (two sheets) of the plat of survey is inclosed herewith.

The length of river surveyed is 24.2 miles. The average fall per mile is 3.161 feet. Low-water discharge is 200 cubic feet per second, high-water discharge 45,000 cubic feet per second (estimated).

My opinion is that the only way to make navigable water in Buffalo Fork of White River at all stages of water is by means of locks and fixed dams, and that this method is only practicable by making the assumption that the dams will not leak.

It would require at least five locks and dams to overcome the difference in level between the mouth of Buffalo Fork and mouth of Rush Creek. It is estimated that five locks and dams would cost $750,000, making the cost of improvement about $30,990 per mile. In my opinion the commerce that would be developed would not justify this expenditure.

There are rich deposits of zinc ore on this stream in the vicinity of the mouth of Rush Creek, and an attempt is being made on a small scale to "flatboat" this material to White River.

The timber along this stream is plentiful and is being rafted to White River, thence to market. These two sources of commerce make this stream, in my opinion, worthy of the following improvement, viz:

To cut the overhanging timber and remove from the shoals the loose and solid rock that project above the general plane of the bed of the shoals, from the mouth to the mouth of Rush Creek.

It is estimated that the cost of the above work will be $3,500.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
St. Louis, Mo., January 11, 1897.

Respectfully forwarded to the Chief of Engineers, concurring in the views of the district engineer.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. WILLIAM PARKIN, ASSISTANT ENGINEER.

LITTLE ROCK, ARK., *January 4, 1897.*

CAPTAIN: In compliance with your verbal order of November 30, 1896, I have the honor to submit the following report of survey and examination of Buffalo Fork of White River, Arkansas, from Rush Creek to the mouth, made during the month of December, 1896.

The actual field work was commenced December 5 and completed December 20. Levels were run from the mouth of the river across country to the mouth at Rush Creek to obtain the fall between the two terminal points, and the fall at the principal shoals was obtained by transit level while survey was in progress. Temporary gauges were established, but the river was practically stationary throughout the entire survey.

Buffalo River rises in the southwestern part of Newton County and flows in a general easterly direction through Newton, Searcy, and Marion counties, an estimated distance of 200 miles.

WATERSHED.

With its tributaries it has an approximate watershed of 1,350 square miles. The tributaries, though small, are numerous, the entire watershed being very rugged and mountainous. On account of the character of the country through which it runs the river rises and falls very quickly.

DISTANCE.

The distance by channel measurement from Rush Creek to the mouth is 24.2 miles, and the principal characteristics of the river in this distance, as determined by the survey, are as follows:

Valley.—Average width, 900 feet; minimum, 450 feet; maximum, about 2,000 feet, and 80 per cent of the farm lands are above overflow. All the farming lands are good.

Widths.—Average at high water, 325 feet. This is sometimes increased at a very few sharp bends to 600 feet, as shown by map. Average at low water, 140 feet; minimum, 35 feet; maximum, 285 feet.

Banks.—Average, 37 feet high and do not cave, the bend side being nearly always a rock bluff. When the concave side is not of rock the bank is heavy clay soil that caves not at all and wears away slowly. The banks are everywhere covered with heavy overhanging timber, much in the way of navigation by steamboats or barges.

Oscillation.—From various sources the oscillation was finally determined to be 35.5 feet. At Rush Creek it was 35.75 feet, and at Buffalo City about 38 feet

Depths at present stage.—In bends and reaches, from 18 inches to 15 feet; on shoals from 5 to 18 inches for a boat 5 feet wide. When the river gets down to about low water on several shoals it takes a skillful hand to guide a light bateau through the rapids without an accident. In some cases the water is divided into several little chutes and has little depth, while in others bowlders are thick and make the channel very crooked. In fact there is no channel for anything but narrow bateaux.

Bed of river.—Generally solid rock. Sometimes gravel and loose rock at shoals and in a few pools, but all are underlaid with solid rock at a slight depth.

Shoals.—The shoals are 46 in number, and their names, extent, fall, and depth, together with the nature of bottom, are given in the accompanying table. The greatest fall is at Cedar Creek, where there is a descent of 4.3 feet in 350 feet. About one-half of the shoals show gravel bottom, the balance solid rock or loose rock, and some gravel. All rock shoals are full of loose bowlders and many needle-rocks projecting from a solid bed.

Fords.—About 14 in number; all included in the above list of shoals.

Bars.—Are gravel; no sand bars. Nearly all the bars are covered with a growth of scrubby willow from 10 to 15 feet high, there being but one entirely open bar on this part of the river. (See map.)

Slope.—The fall from Rush Creek to the mouth, 24.2 miles, is 76.5 feet=3.161 feet per mile. At the time the survey was made both White and Buffalo rivers were about 0.6 foot above low water. Backwater of White River is said to come up to Tinnan Shoals, 5.3 miles above the mouth.

Discharge.—A discharge observation was taken 1 mile above the mouth at stage supposed to be 0.6 foot above low water, and a discharge of 295.01 cubic feet per second obtained. Reducing to a stage 0.6 foot lower and assuming velocity and slope to remain the same, the discharge is 230.16 cubic feet per second. It is probable that it is very close to 200 feet per second at low water.

The discharge at high water is estimated at 45,000 cubic feet per second.

Obstructions.—Consist of the 46 shoals mentioned above and shown in the appended table and also on map, the steep slope, overhanging timber, and the abrupt turns in the channel. Twenty-six of the shoals are either solid reef rock, or loose rock and gravel, while 20 appear to be gravel only. Although the water in the narrow channel is as deep on the rock as on the gravel shoals, they do not so soon become passable for boats or rafts on account of the many projecting rocks that are not in the narrow and crooked low-water channel but are in the channel for a flatboat or raft, at stage at which they could safely go over the gravel shoals. Three fish traps are included in shoals. They can be easily removed.

Overhanging timber is also very much in the way of any kind of navigation, especially in the narrow chutes and at the abrupt bends. The upper 12 miles has much more overhanging timber than the lower 12.

The slope would seem to be very much of an obstruction also, but when it is at all distributed by about a 4-foot stage of water it can be overcome by boats of small power, the steamer *Dauntless* going to the mouth of Rush Creek on an experimental trip at a 4-foot stage during the year of 1896. The boat drew 12 inches. Frequent stops had to be made to cut the overhanging timber, and several of the worst shoals had to be lined over. Several boats have been up the river for the first 5 miles during high or medium stages for cotton, but the *Dauntless* was the first steamboat up as far as Rush Creek. The *Dauntless* has a tonnage of 73.49 and load draft of 2 feet 6 inches.

FORMER NAVIGATION.

With the exception of the few trips made by boats in the first 5 miles of river, and the trip of the *Dauntless* to Rush Creek, navigation has consisted entirely of flatboats and rafts; the former coming out at any stage above 5 feet, the latter at as low as 4-foot stage.

The rafts could come out on somewhat lower water, but seldom do, as they prefer to wait for a good rise which will carry them quickly to market.

Rafts are nearly all cedar, telegraph poles, posts, or piles. Immense quantities of this material have come out of the river for years, and now a great many oak ties are being gotten out which are rafted to Batesville on White River.

The flatboats are generally of cheap construction, built for the trip only, with the expectation of selling at the lower end of the run or of losing as little as possible if a sale can not be made.

This kind of navigation under the most favorable conditions is on this river decidedly dangerous, on account of the overhanging timber, the rock obstructions in the channel, and the difficulty experienced in keeping away from the timber and bluffs at the abrupt turns.

The freight carried on these boats consists almost entirely of zinc ore, and the miners figure on building barges to cost $1 for every ton capacity, and they generally carry a load of about 35 to 40 tons. Probably not over six of these boats go down the river in the course of twelve months. A few have come from 30 miles above Rush Creek.

COUNTRY.

The section tributary to Buffalo River is exceedingly well watered. Creeks and springs are numerous, and few fail in the dryest weather. The forests are practically untouched with the exception of the cedar which has been cut for about fifteen years, and most of it near the river is gone. The two principal and most valuable timbers now are oak and pine. Post, white, overcup, and red oak are the prevailing kinds of oak, while all of the pine is of the short-leaf yellow variety. Other timbers are gum, ash, sycamore, beech, linn, cottonwood, and elm, but oak and pine is the real timber of the country.

On account of the country being so rough the farms are generally small until the flats are reached in the uplands, from 5 to 8 miles from the river. In these tablelands the country is more settled, the farms larger, and there most of the villages are located. Many of the people who farm the bottom lands stay there only until the crops are laid by, when they return to the uplands till time to gather the crop.

I understand that a statement is being prepared by the board of trade of Yellville, the county seat of Marion County, which will show the total production of all kinds in Marion County, but nothing of the kind is at present available.

That the country is rich in minerals, especially in zinc and lead, there is no doubt, but few of the mines are now working, partly on account of the business troubles during the past year or two, but principally on account of the dislike of capital to invest in an enterprise so far away from regular lines of transportation.

I examined only two properties while there, the Morning Star, on Rush, and the Lion Hill, on Warners Creek. At the former the hillside has been opened up for over 2,000 feet at various points, the main mine, or rather quarry, for it is little else, being about 250 feet long and having a face of over 30 feet in height. In addition to this there is a shaft extending 30 feet below the floor of the mine. The walls of both shaft and quarry and the floor of the mine are full of zinc in its several formations, and very much of it, in fact fully half of it, is free ore that can be shipped without crushing. Of late this mine has made no shipments, although there are several hundred tons on the dumps and hundreds more in sight.

The Lion Hill mine is not nearly so extensive as the Morning Star, so far as actual development is concerned, but on the other hand it has a well-equipped plant, that will crush 100 tons per day. A little mining is going on, but no shipments have been made for some months.

SUMMARY.

To sum up the above briefly: Buffalo Fork of White River, Arkansas, between Rush Creek and the mouth, a distance of 24.2 miles, is a mountainous stream, flowing through a rich valley averaging 900 feet in width, practically all of which is in cultivation and little overflowed. The total watershed of the stream and tributaries is about 1,350 square miles. Course tortuous; current varying from practically nothing in the pools and 6 feet per second on the shoals at low water to 5 or 6 miles per hour during high water.

Banks 37 feet high, and do not cave. Average width at low water, 140 feet; high water, 325 feet; minimum low-water width, 35 feet; oscillation, 35.5 feet.

Depth in bends at low water, 1 to 15 feet, and on shoals as little as 5 inches for a bateau.

Bed of river generally rock, some gravel; 26 rock and 20 gravel shoals. Slope, 3.161 feet per mile.

Low-water discharge, about 200 cubic feet per second. High water estimated at 45,000. The obstructions besides slope and the shoals consist of overhanging timber.

RECOMMENDATION.

Without locks and dams it is not possible to render the river navigable at all stages. It is believed, however, that if the overhanging timber was removed and the rock shoals improved by removing loose and solid rock obstructions that project above the general plane of bed of shoal as was done in White River between the Rapides and Batesville in 1895, and by tearing out the fish traps, of which there are three, navigation could be safely carried on at a stage much lower than at present. It at least would put the stream in a clear condition, and it could be navigated safely when there was water, which is not the case now at any stage.

Judging from past experience, it is believed that the river could be improved as above outlined for $3,500. It could probably be done in one low-water season.

The map of survey is in two sheets, drawn on a scale of 600 feet to the inch, and accompanies this letter.

Very respectfully, your obedient servant,

Wm. Parkin, *Assistant Engineer.*

Capt. Wm. L. Sibert,
Corps of Engineers, U. S. A.

Table showing extent and nature of shoals on Buffalo Fork of White River, Arkansas.

No.	Name of shoal.	Length.	Fall.	Bottom.	Depth for boat 5 feet wide.	Remarks.
		Feet.	*Feet.*		*Inches.*	
1	Clabber Creek	300	3.5	Rock	6	
2	Silver Hollow	200		Gravel and rock	8	
3	Cabin Creek	150		do	6	
4	Cedar Creek	400	4.3	Rocks	6	
5	Boat Creek	150	0.9	Gravel	12	
6	Blind Chute	125	0.5	do	12	Part only.
7	Dog Leg	200	1.0	Gravel and rock	8	
8	Petits Chute	200	1.3	do	12	
9		100	0.5	Gravel	12	
10	Brantleys Ford	500	2.2	do	12	
11	Roaring Rock, No. 1	150	1.5	Gravel and rock	12	
12	Roaring Rock, No. 2	100	1.0	do	12	
13	Weast Ford	100	0.5	Gravel	9	
14	Fish Trap	300	2.8	Rock	6	
15	Wooten Ford	150	0.9	Gravel	15	
16	Brush Creek	200	0.4	Gravel and rock	12	
17	Fish Trap, No. 2	500	2.8	do	16	
18	Warners Ford and	100	1.6	Gravel	8	
19	Fish Trap, just below	25		Rock	5	
20	Slick Rock	75	0.2	do	15	
21	Boone Ford	100	0.4	Gravel	15	

Table showing extent and nature of shoals on Buffalo Fork of White River, Arkansas—Continued.

No.	Name of shoal.	Length.	Fall.	Bottom.	Depth for boat 5 feet wide.	Remarks.
		Feet.	*Feet.*		*Inches.*	
22	Rocky Ford	450	3.5	Rock	6	Upper end.
23		100	0.5	Gravel	12	Lower end.
24	Rose Berry Chute	250	1.0	Gravel and rock	12	
25	Fish Trap in lower end	40	1.0	Rock	6	
26	Rice Ford			Gravel	10	
27	do	70	0.6	do	5	Second section.
28	Woodcocks Ford	125	1.5	do	5	
29	Woodcocks Old Mill Dam	200	1.9	Rock	6	Nearly gone.
30	Greasy	250	2,6	Gravel and rock	10	Part only.
31	Spencer Ford	250	1.0	Gravel	8	
32	Fox Bar	225	1.0	do	15	
33	Leatherwood	300	3.2	Rock	8	
34	Fosters	250	1.0	Gravel	10	
35	Sheeps Jump	150	1.3	Gravel and rock	18	
36	O. Shield's Ford	200	0.7	Gravel	10	Do.
37	O. Shield's Chute	250	1.5	Rock	10	Do.
38	Tinnans Rock	300	1.5	Gravel and rock	12	
39	Cow Rock	450	2.4	Rock	10	
40	Campbells	325	2.2	do	15	
41	Birds Ford	300	2.0	do	12	
42	Hudsons Bend Shoals	300	3.4	do	12	Do.
43	Goodmans Ford	350	1.2	Gravel	18	
44	Gin Eddy	300	1.5	do	15	
45	Cut-off	225	1.0	do	14	
46		175	0.9	do	10	

V 13.

SURVEY OF ST. FRANCIS RIVER, ARKANSAS AND MISSOURI, FROM THE SUNK LANDS TO POPLIN, MISSOURI.

[Printed in House Doc. No. 82, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated November 24, 1896, by Capt. William L. Sibert, Corps of Engineers, relative to survey and estimate of cost of improvement of St. Francis River from the Sunk Lands to Poplin, Mo., required by the river and harbor act of June 3, 1896.

The data necessary to the preparation of a project being at hand, no survey was made. The plan of improvement proposed is to clear the river of snags, drifts, and overhanging timber and to confine the river to one channel from the head of the Sunk Lands to Chalk Bluff, and to remove obstructions of the same nature that interfere with navigation at medium and high stages of water from Chalk Bluff to Poplin. The estimated cost of this work is $11,200, and it is estimated that it will require $2,000 per year to remove the annual accumulation of snags, etc., in this reach of the river after the proposed improvement has been accomplished.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. WILLIAM L. SIBERT, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Little Rock, Ark., November 24, 1896.

GENERAL: I have the honor to submit the following report concerning a survey of St. Francis River, Arkansas and Missouri, from the Sunk Lands to Poplin, Mo. In report on preliminary examination of the above portion of St. Francis River, submitted to your office July 27, 1895, it was stated that no survey was necessary in preparing a project for the work proposed. All data necessary to the preparation of the project being in the office, no survey was made.

PROPOSED PROJECT AND ESTIMATE.

It is proposed to thoroughly clear the river of snags, drifts, and overhanging timber from the head of the Sunk Lands to Chalk Bluff, 28 miles, and to confine the river to one channel; to remove the snags, drifts, and overhanging timber that interfere with navigation at medium and high stages of water from Chalk Bluff to Poplin, Mo., a distance of 56 miles.

It is estimated that it will cost $200 per mile to effect the proposed improvement from the head of the Sunk Lands to Chalk Bluff, and $100 per mile from Chalk Bluff to Poplin, Mo.

For 28 miles, at $200 per mile	$5,600
For 56 miles, at $100 per mile	5,600
Total	11,200

It is estimated that it will require $2,000 per year to remove the annual accumulation of snags, etc., in this reach of river after the proposed improvement is once accomplished.

In my opinion, the St. Francis River from the Sunk Lands to Poplin, Mo., is worthy of the proposed improvement and that the same is justified by the commerce involved.

Very respectfully, your obedient servant,

WM. L. SIBERT,
Captain of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
November 27, 1896.

Respectfully forwarded to the Chief of Engineers recommended for approval.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

APPENDIX W.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER; IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS, OF HARBOR AT ST. LOUIS, MISSOURI, AND TO PREVENT THE MISSISSIPPI FROM BREAKING THROUGH INTO CACHE RIVER AT BEACH RIDGE, ABOVE CAIRO, ILLINOIS.

REPORT OF MAJ. THOMAS H. HANDBURY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Removing snags and wrecks from Mississippi River.
2. Mississippi River between the Ohio and Missouri rivers.
3. Harbor at St. Louis, Missouri.
4. To prevent the Mississippi River from breaking through into Cache River at Beach Ridge, above Cairo, Illinois.

UNITED STATES ENGINEER OFFICE,
St. Louis, Mo., July 12, 1897.

GENERAL: I have the honor to transmit herewith the annual report for the works under my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

THOS. H. HANDBURY,
Major, Corps of Engineers, U. S. A.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

W 1.

REMOVING SNAGS AND WRECKS FROM MISSISSIPPI RIVER.

Before this work was inaugurated the navigation of the river was very much interfered with by numerous snags, logs, etc., which had lodged in the channel, and to which a new accession was brought down on each rise of the river, thus constantly adding new and unknown obstructions to those already there. A large number of wrecks, dangerous to navigation, also occupied the channel. For the removal of these obstructions appropriations were made as early as 1824, and the project adopted consisted of building boats suitable for removing the snags, etc., and operating them by hired crews whenever the stage of water was favorable for the work and funds were available.

The total amount expended for this purpose can not be definitely given, as previous to the appropriations made by act of March 3, 1879, a general amount was appropriated to be applied to several streams as their needs required.

The first specific sum for removing snags, wrecks, etc., from the Mississippi River was appropriated by act of March 3, 1879, and was followed by other appropriations until 1888, when, by the act of August 11 of that year, an annual expenditure not to exceed $100,000 for this purpose was authorized. Under that act operations have since been carried on continuously.

This work is now being done through the instrumentality of two large steel-hulled snag boats, *H. G. Wright* and *J. N. Macomb*, outfitted with all necessary tools and appliances and operated by hired men.

OPERATIONS DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

The *H. G. Wright*, after undergoing thorough repair, left St. Louis under command of Capt. R. E. Birch July 21, to commence her season's operations. A trip to Cairo and return was made, occupying one week. The river during that time had risen to a stage making it unnecessary and unprofitable to do snagging work. She was therefore laid up at St. Louis until September 2, when, the river having reached a favorable stage, operations were resumed and continued until March 12, at which time the river was at a high stage and the boat was laid up in ordinary for necessary repairs.

This boat patrolled the river between St. Louis and Memphis. During the month of November one trip was extended to New Orleans.

In September a large barge belonging to the Mississippi Valley Transportation Company, loaded with corn, was sunk in the vicinity of Ste. Genevieve in such a way as to obstruct the channel. The company not being able to remove this, declared it abandoned. Orders were given to the captain of the *Wright* to blow it up with dynamite and remove the pieces. This was done and the channel cleared.

The *J. N. Macomb*, under command of Capt. Alex. H. Stewart, having undergone all needful repairs, resumed operations August 17 and continued until March 18, when she was laid up in ordinary and for repairs at Bushberg on account of high water in the river.

On March 23 an urgent call for assistance was received from the president of the Chicago and Texas Railway Company. A bridge over the Big Muddy River near where it empties into the Mississippi had broken down, wrecking a locomotive and five cars and killing an engineer and fireman. The accident was caused by high water undermining the abutment of the bridge. The bridge could not be replaced and communication reestablished until the wreckage was removed. The company was without facilities for doing this and could not procure them elsewhere. Under these circumstances the captain of the *Macomb* was directed to go to their assistance, which he did on March 24. On April 10 the boat returned to Bushberg, having accomplished the work of removing the wreck in a manner highly satisfactory to the officers of the railroad company. The Government was at no additional expense on account of this work. All above what would have been the expense of the boat in ordinary was defrayed by the company.

On June 9, 1897, the *Macomb* left St. Louis for a trip over the river as far as Memphis and return, a number of snags having been reported as being in the navigable channel. She returned to Bushberg on June 25 to await a more favorable stage of water for working.

The work accomplished by the two snag boats during the fiscal year is given in the following table:

Name.	Snags pulled.	Trees cut.	Drift piles removed.	Wrecks removed.	Miles run.
H. G. Wright	1,233	19,778	9	1	6,469
J. N. Macomb	1,839	11,236	15	[a] 1	9,509
Total	3,072	31,014	24	2	15,978

[a] Train from Big Muddy River.

The trees referred to are generally leaning timber in bends of the river or trees that are liable to fall into the water and become obstructions to navigation.

An annual appropriation of an amount not to exceed $100,000 having been made for the work, the snag boats will patrol the river whenever necessary in order to keep the channel free from obstructions such as snags, logs, drift piles, leaning trees, and such small wrecks as they may be able to handle. The removal of large, heavy, or numerous wrecks by snag boats is not contemplated, the boats not having been built for such purpose.

EXPENDITURES.

The amount expended on this work to July 1, 1896, under all specific and annual appropriations since and to include March, 1879, is $1,199,506.72.

Amount expended from current allotment during the fiscal year, $83,421.64. A detailed statement of this expenditure as required by law is given in the accompanying tables 1 and 2. The total expenditures during the year, including the outstanding liabilities of $100.32 at the beginning of the year, were $83,521.96.

The work was all done by hired labor. In general the material has been purchased from the lowest bidder for the most suitable article, after ten days' advertisement for proposals. In many cases this method was impracticable. Purchases were then made in open market in the manner usually pursued by private individuals. The work done by the snag boats is of great benefit to the commerce and navigation on the river. Before the work was so completely patrolled as it now is the sinking of steamboats and other river craft by running on snags was a common occurrence. During recent years such disasters seldom happen. Although life and property would seem to be much safer now than formerly, the rate of insurance has not materially decreased.

It is proposed during the coming fiscal year to continue operating these snag boats as provided for in the river and harbor act of August 11, 1888.

The statistics relating to the commerce benefited by the operations of these snag boats will be found in the report of operations for this year for the improvement of the Mississippi River from the mouth of the Missouri to the mouth of the Ohio River.

The headquarters of the snag boats is in St. Louis, which is the nearest port of entry, and which is in the collection district of New Orleans.

The amount of customs collected at St. Louis during the fiscal year was $1,139,723.86.

The amount of internal revenue collected was $6,825,959.28.

Money statement.

Amount to be drawn under section 7, act of August 11, 1888	$83,421.64
June 30, 1897, amount expended during fiscal year	83,421.64
July 1, 1897, amount available for fiscal year 1897–98	100,000.00

Appropriations made by Congress for removing obstructions in Mississippi River.

By the act of—		For fiscal year ending—	
March 3, 1879	$100,000.00	June 30, 1891	$92,720.97
June 14, 1880	100,000.00	June 30, 1892	98,250.00
March 3, 1881	80,000.00	June 30, 1893	96,497.23
March 2, 1882	85,000.00	June 30, 1894	88,252.46
July 5, 1884	72,950.63	June 30, 1895	100,000.00
August 5, 1886	56,250.00	June 30, 1896	80,496.26
August 11, 1888	100,000.00	June 30, 1897	83,421.64
For fiscal year ending—			
June 30, 1890	49,089.17	Total	1,282,978.36

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River during the fiscal year 1897, as required by section 7 of the river and harbor act of August 11, 1888.*

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1896.				
July	1	Con. P. Curran Printing Co	Supplies	$6.25
	2	Cairo City Coal Co	Coal	48.00
	3	J. H. Friant	Sawing logs	6.00
	4	Sundry persons	Pay roll	353.00
	5	do	do	1,573.34
	6	do	do	103.92
	7	do	do	1,254.67
	8	J. D. Reed	Services	1.17
	9	Anchor Line store	Supplies	27.12
	10	Brockman & Trauernicht	do	111.41
	11	Chas. W. Barstow	Turpentine	14.04
	12	A. G. Brauer	Supplies	4.70
	13	M. M. Buck Manufacturing Co	do	48.21
	14	Eagle Boat Store Co	do	29.03
	15	Simmons Hardware Co	Water cooler	3.25
	16	Thos. Sexton Stove and Range Co	Supplies	6.90
	17	Waters Pierce Oil Co	Oil	17.88
	18	Sundry persons	Pay roll	21.00
	19	Whitelaw Bros	Supplies	44.10
Aug	1	Bauer Grocer Co	do	216.73
	2	Adolph J. Bentzen	do	167.95
	3	Big Muddy Coal and Iron Co	Coal	67.50
	4	Fischer Packing Co	Supplies	96.22
	5	Fairbanks, Morse & Co	do	20.27
	6	Huse & Loomis Ice and Transportation Co	Ice	72.22
	7	John Lowell	Supplies	114.54
	8	Western Brass Manufacturing Co	do	23.62
	9	Moffitt-West Drug Co	do	12.50
	10	Sylvester Coal Co	Coal	13.58
	11	Whitelaw Bros	Supplies	24.69
	12	R. Bush	do	7.88
	13	Page & Tolkacz	do	5.20
	14	Western Union Telegraph Co	Telegrams	.20
	15	Fred Holdinghausen	Services	5.00
	16	M. Dougherty	Supplies	319.79
	17	Wm. Barr Dry Goods Co	Mosquito netting	6.50
	18	G. D. Williamson	Supplies	19.53
	19	Sundry persons	Pay roll	500.00
	20	Cairo City Coal Co	Coal	72.00
	21	Crown Coal and Tow Co	do	240.11
	22	Providence Jewelry Co	Clocks	8.20
	23	Sundry persons	Pay roll	1,765.00
	24	do	do	1,461.82
Sept	1	C. E. Livingston	Ice	8.00
	2	Chas. Kney	Fresh meat	56..0
	3	Pittsburg Coal Co	Coal	140.00

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1896.				
Sept	4	Jas. A. Tappan	Coal	$105.00
	5	Matt Monaghan & Co	Supplies	69.85
	6	John J. Ganahl Lumber Co	Lumber	23.85
	7	Anchor Line store	Charcoal	2.00
	8	Adolph J. Bentzen	Supplies	207.54
	9	Big Muddy Coal and Iron Co	Coal	45.00
	10	Crown Coal and Tow Co	do	65.00
	11	Huse & Loomis Ice and Transportation Co	Ice	92.31
	12	E. Jaccard Jewelry Co	Repairing clock	.75
	13	L. S. Koerber	Supplies	84.71
	14	John Lowell	do	163.01
	15	Pittsburg Coal Co	Coal	240.00
	16	Simmons Hardware Co	Hand saw	1.00
	17	Ewald Iron Co	Iron	2.46
	18	Western Union Telegraph Co	Telegrams	1.00
	19	Adolph J. Bentzen	Supplies	77.22
	20	John Lowell	do	79.29
	21	David Nicholson	do	13.73
	22	Natchez Ice Co	Ice	28.00
	23	Peterson & Holmes	Supplies	5.25
	24	J. H. Pocock Can Co	Milk cans	6.30
	25	Wm. Barr Dry Goods Co	Supplies	12.40
	26	H. E. Coffin	do	74.15
	27	H. A. Carroll & Co	do	27.30
	28	Harbison Bros. & Co	do	59.52
	29	Horn & Co	do	26.61
	30	Chas. Kney	Meat	56.80
	31	Lee Bros	Supplies	19.70
	32	Peatross Cameron & Co	Coal	216.00
	33	Pittsburg Coal Co	do	220.00
	34	Valentine Resch	Supplies	41.90
	35	G. T. Sams & Co	do	21.80
	36	Jas. A. Tappan	Coal	140.00
	37	Van Vleit-Mansfield Drug Co	Supplies	3.63
	38	Western Electrical Supply Co	do	6.58
	39	The Ætna Powder Co	do	321.00
	40	Saml. L. Downing & Co	Repairs	1.00
	41	P. H. Dempsey	Supplies	46.93
	42	Matt Monaghan & Co	do	79.60
	43	Jas. A. Tappan	Coal	90.00
	44	Sundry persons	Pay roll	355.00
	45	do	do	1,862.09
	46	do	do	327.67
	47	do	do	1,789.00
	48	do	do	360.00
	49	Big Muddy Coal and Iron Co	Coal	90.00
	50	Cairo City Coal Co	do	118.80
	51	Huse & Loomis Ice and Transportation Co	Ice	30.93
	52	Crown Coal and Tow Co	Coal	143.00
Oct	1	L. S. Koerber	Supplies	117.10
	2	Natchez Ice Co	Ice	21.00
	3	The Oliver-Finnie Grocer Co	Supplies	420.79
	4	Peatross Cameron & Co	Coal	63.00
	5	Smith Torrance	Repairs	46.00
	6	Chas. Kney	Supplies	77.35
	7	Missouri Car and Foundry Co	Lumber	178.34
	8	Matt Monaghan & Co	Supplies	65.23
	9	Pittsburg Coal Co	Coal	497.50
	10	Anchor Line store	Supplies	80.84
	11	Broderick & Bascom Rope Co	Spun yarn	4.26
	12	Brockman & Trauernicht	Supplies	84.69
	13	H. E. Coffin	Scrub brushes	2.20
	14	M. Dougherty	Supplies	63.90
	15	Chas. Kney	Meat	84.64
	16	John Lowell	Supplies	51.18
	17	Matt Monaghan & Co	do	114.80
	18	Peatross Cameron & Co	Coal	120.00
	19	Pittsburg Coal Co	do	173.50
	20	E. E. Souther Iron Co	Supplies	10.10
	21	J. D. Streett & Co	do	2.00
	22	Schaeffer Bros. & Powell Manufacturing Co	Soap	18.60
	23	Jas. A. Tappan	Coal	120.00
	24	H. G. Vreeland & Son	Soap	20.00
	25	Zittlosen Manufacturing Co	Flag	7.00
	26	Cairo City Coal Co	Coal	73.20
	27	Valentine Resch	Supplies	37.05
	28	Geo. T. Sams & Co	do	88.17
	29	Chas. W. Barstow	Sal soda	2.42
	30	M. M. Buck Manufacturing Co	Supplies	208.95

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1896.				
Oct....	31	Eau Claire-St. Louis Lumber Co	Lumber	$19.68
	32	A. Holderby	Supplies	10.90
	33	Missouri Car and Foundry Co	Lumber	8.96
	34	Moffitt-West Drug Co	Medicines	4.20
	35	Western Union Telegraph Co	Telegrams	2.88
	36	Sundry persons	Pay roll	500.00
	37	.....do	.....do	1,824.33
	38	.....do	.....do	266.50
	39	.....do	.....do	90.34
	40	.....do	.....do	1,729.17
	41	.....do	.....do	420.00
	42	The Ætna Powder Co	Dynamite	77.50
	43	Big Muddy Coal and Iron Co	Coal	195.00
	44	Adolph J. Bentzen	Supplies	35.29
	45	Huse & Loomis Ice and Transportation Co.	Ice	11.57
	46	Chas. Kney	Meat	23.44
	47	The Knapp Stout & Co. Company	Lumber	3.97
	48	Matt Monaghan & Co	Supplies	34.60
	49	N. O. Nelson Manufacturing Co	.....do	23.72
	50	Pittsburg Coal Co	Coal	270.00
Nov ...	1	Cairo City Coal Co	.....do	171.20
	2	.....do	.....do	72.00
	3	John Lowell	Supplies	51.75
	4	Valentine Resch	.....do	7.00
	5	Simmons Hardware Co	.....do	12.91
	6	Bauer Grocer Co	.....do	201.81
	7	Crown Coal and Tow Co	Coal	173.80
	8	Eagle Boat Store Co	Oil	20.00
	9	L. A. Fleckinger	Supplies	24.55
	10	Robt. G. Hogan & Co	Tea	2.90
	11	Chas. Kney	Meat	65.60
	12	L. S. Koerber	Supplies	73.35
	13	Matt Monaghan & Co	.....do	91.45
	14	Natchez Ice Co	Ice	14.00
	15	Pittsburg Coal Co	Coal	120.00
	16	C. Pichetto	Supplies	31.60
	17	Wm. Ratican	Coal	175.00
	18	L. M. Rumsey Manufacturing Co	Supplies	.73
	19	Jas. A. Tappan	Coal	120.00
	20	Wood, Bodley & Co	.....do	62.50
	21	W. G. Coyle & Co	.....do	215.00
	22	Natchez Ice Co	Supplies	24.50
	23	E. E. Souther Iron Co	Steel	20.85
	24	Western Union Telegraph Co	Telegrams	4.49
	25	L. S. Koerber	Supplies	64.29
	26	Peatross Cameron & Co	Coal	123.00
	27	C. Pichetto	Supplies	14.30
	28	A. P. Rabito	.....do	10.90
	29	Louis Ruch	.....do	28.50
	30	Shaw & Sons	Repairs	25.00
	31	Sundry persons	Pay roll	355.00
	32	.....do	.....do	1,175.00
	33	.....do	.....do	966.00
	34	.....do	.....do	1,825.00
	35	.....do	.....do	330.00
	36	Chas. Kney	Meat	54.24
	37	L. P. Laurent	Supplies	54.88
	38	Natchez Ice Co	Ice	21.00
	39	Peatross Cameron & Co	Coal	184.50
	40	Pittsburg Coal Co	.....do	685.00
	41	Jas. A. Tappan	.....do	120.00
Dec....	1	Baldwin, Knowlton & Lake	Supplies	116.99
	2	Cairo City Coal Co	Coal	98.00
	3	Chas. Kney	Supplies	72.24
	4	Matt Monaghan & Co	.....do	131.19
	5	Pittsburg Coal Co	Coal	75.00
	6	Geo. T. Sams & Co	Supplies	16.88
	7	Jas. A. Tappan	Coal	120.00
	8	Arrow Boiler Compound Co	Boiler compound	68.90
	9	M. M. Buck Manufacturing Co	Supplies	18.89
	10	Brockman & Trauernicht	.....do	77.11
	11	Big Muddy Coal and Iron Co	Coal	67.50
	12	Adolph J. Bentzen	Supplies	38.74
	13	Howard Ewald & Co	.....do	27.69
	14	Fairbanks, Morse & Co	.....do	19.42
	15	Goodyear Rubber Co	Rubber boots	10.20
	16	Wm. O. Gibson & Son Grocer Co	Supplies	46.83
	17	L. S. Koerber	.....do	37.40
	18	John Lowell	.....do	53.51
	19	Matt Monaghan & Co	.....do	61.91
	20	The Oliver-Finnie Grocer Co	.....do	374.46

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1896. Dec	21	Paddock-Hawley Iron Co	Supplies	$5.81
	22	Postal Telegraph Cable Co	Telegrams	.20
	23	Schaeffer Bros. and Powell Manufacturing Co.	Soap	18.00
	24	Simmons Hardware Co	Supplies	11.44
	25	Salomo-Biederman Hardware Co	do	4.65
	26	Jas. A. Tappan	Coal	90.00
	27	Western Electrical Supply Co	Supplies	2.34
	28	Western Union Telegraph Co	Telegrams	4.11
	29	Peatross Cameron & Co	Coal	123.00
	30	Leonard & Ellis	Oil	5.00
	31	L. P. Laurent	Supplies	23.00
	32	Peatross Cameron & Co	Coal	153.00
	33	W. L. Ray	Supplies	19.85
	34	Pittsburg Coal Co	Coal	402.00
	35	Aaron Meyers	Supplies	16.74
	36	James A. Tappan	Coal	120.00
	37	Anchor Line Store	Supplies	17.99
	38	Bauer Grocery Co	do	52.87
	39	Big Muddy Coal and Iron Co	Coal	45.00
	40	Crown Coal and Tow Co	do	78.00
	41	Cairo City Coal Co	do	96.00
	42	M. Dougherty	Supplies	82.70
	43	Eagle Boat Store Co	do	91.36
	44	F. J. Longmeyer	Coal	33.85
	45	David Nicholson	Supplies	35.57
	46	Platt & Thornburgh Paint and Glass Co	do	15.70
	47	Geo. T. Sams & Co	do	25.83
	48	Simmons Hardware Co	do	42.82
	49	J. D. Streett & Co	do	30.10
	50	Sligo Iron Store Co	do	42.84
	51	Salamo-Biederman Hardware Co	Brushes	2.22
	52	Western Electrical Supply Co	Supplies	9.10
	53	Broderick & Bascom Rope Co	Lampwick	.50
	54	M. M. Buck Manufacturing Co	Supplies	31.07
	55	H. L. Ettman & Co	Sponges	7.50
	56	S. E. Grote Paint Store Co	Supplies	1.35
	57	Interstate Oil Co	Oil	7.25
	58	Missouri Car and Foundry Co	Lumber	90.80
	59	Zittlosen Manufacturing Co	Duck	4.20
	60	Revere Rubber Co	Packing	2.08
	61	Sundry persons	Pay roll	300.00
	62	do	do	1,310.00
	63	do	do	855.90
	64	do	do	1,795.00
	65	do	do	857.00
	66	Cairo City Coal Co	Coal	98.00
	67	Geo. T. Sams & Co	Supplies	38.93
1897. Jan	1	Chas. Kney	Meat	74.24
	2	Matt Monaghan & Co	Supplies	150.30
	3	Pittsburg Coal Co	Coal	150.00
	4	Jas. A. Tappan	do	60.00
	5	Leonard & Ellis	Oil	18.45
	6	Fairbanks, Morse & Co	Supplies	94.05
	7	Huse & Loomis Ice and Transportation Co	Ice	8.40
	8	A. Holderby	Milk	4.25
	9	Chas. Kney	Meat	58.80
	10	L. S. Koerber	Supplies	65.50
	11	Matt Monaghan & Co	do	77.37
	12	Pittsburg Coal Co	Coal	285.00
	13	Peatross Cameron & Co	do	198.00
	14	Valentine Resch	Supplies	27.10
	15	Western Union Telegraph Co	Telegrams	3.51
	16	Adolph J. Bentzen	Supplies	40.40
	17	Big Muddy Coal and Iron Co	Coal	45.00
	18	A. G. Brauer	Supplies	8.22
	19	John Lowell	do	41.17
	20	L. P. Laurent	do	71.55
	21	Baldwin, Knowlton & Lake	do	247.74
	22	H. E. Coffin	do	131.20
	23	C. E. Kennedy	do	4.50
	24	Chas. Kney	Meat	145.52
	25	Matt Monaghan & Co	Supplies	192.20
	26	Nohsey & Schwab	Stovepipe	5.50
	27	The Oliver-Finnie Grocer Co	Supplies	287.48
	28	F. Ozanne	Coal hods	2.50
	29	Pittsburgh Coal Co	Coal	660.12
	30	Cairo City Coal Co	do	144.00
	31	A. Holderby	Milk	2.75
	32	Lee Brothers	Supplies	87.58

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897. Jan	33	F. J. Longmeyer	Coal	$43.05
	34	Valentine Resch	Supplies	18.25
	35	Geo. T. Sams & Co	do	32.52
	36	Jas. A. Tappan	Coal	165.00
	37	J. T. Ferguson	Wood	55.00
	38	Sundry persons	Pay roll	973.00
	39	do	do	355.00
	40	do	do	1,795.00
	41	do	do	360.00
	42	do	do	1,175.00
Feb	1	Towner & Co	Supplies	24.45
	2	J. E. Le Duke	Wood	20.00
	3	P. T. Langan	Lumber	38.25
	4	N. B. Ward	Supplies	73.22
	5	L. S. Koerber	do	7.60
	6	Peatross Cameron & Co	Coal	195.00
	7	Western Union Telegraph Co	Telegrams	3.32
	8	William Isom	Services	5.00
	9	L. P. Laurent	Supplies	67.05
	10	Anchor Line Store	do	75.73
	11	A. G. Brauer	do	2.30
	12	M. M. Buck Manufacturing Co	do	16.15
	13	Cairo City Coal Co	Coal	262.00
	14	Chas. Kney	Meat	78.24
	15	John Lowell	Supplies	46.83
	16	Pittsburg Coal Co	Coal	120.00
	17	Simmons Hardware Co	Supplies	4.10
	18	Jas. A. Tappan	Coal	120.00
	19	H. G. Vreeland & Son	Supplies	8.55
	20	Valentine Resch	do	48.50
	21	Arrow Boiler Compound Co	Boiler compound	71.50
	22	Big Muddy Coal and Iron Co	Coal	45.00
	23	Chas. W. Barstow	Supplies	7.10
	24	Bauer Grocer Co	do	90.66
	25	F. W. Brockman Commission Co	do	21.45
	26	W. R. Colcord	Screws	1.36
	27	Crown Coal and Tow Co	Coal	65.00
	28	M. Dougherty	Supplies	26.62
	29	A. Holderby	Milk	3.25
	30	Hart Coal Co	Coal	7.90
	31	A. M. Nelson Paint Co	Supplies	7.05
	32	David Nicholson	do	25.85
	33	Pittsburg Coal Co	Coal	285.00
	34	L. M. Rumsey Manufacturing Co	Supplies	6.01
	35	William Ratican	Coal	40.80
	36	Geo. T. Sams & Co	Supplies	42.47
	37	J. D. Streett & Co	Oil	5.10
	38	Sundry persons	Pay roll	355.00
	39	do	do	1,795.00
	40	do	do	360.00
	41	do	do	962.00
	42	do	do	1,175.00
Mar	1	A. A. Ehrman	Supplies	91.99
	2	L. S. Koerber	Milk	3.15
	3	Peatross Cameron & Co	Coal	228.00
	4	Adolph J. Bentzen	Supplies	29.55
	5	The Consolidated Coal Co. of St. Louis	Coal	70.20
	6	Huse & Loomis Ice and Transportation Co	Ice	11.80
	7	Matt Monaghan & Co	Supplies	38.25
	8	do	do	129.26
	9	Western Union Telegraph Co	Telegrams	3.21
	10	Chas. Kney	Meat	58.16
	11	Cairo City Coal Co	Coal	49.20
	12	Chas. Kney	Supplies	57.76
	13	Leonard & Ellis	Oil	27.25
	14	Matt Monaghan & Co	Supplies	71.67
	15	Pittsburg Coal Co	Coal	390.00
	16	do	do	120.00
	17	Jas. A. Tappan	do	120.00
	18	Adolph J. Bentzen	Supplies	19.80
	19	N. O. Nelson Manufacturing Co	Pipe	.75
	20	Sundry persons	Pay roll	216.50
	21	J. H. Friant	Sawing logs	12.75
	22	John Lowell	Supplies	55.69
	23	Cairo City Coal Co	Coal	50.00
	24	Fairbanks, Morse & Co	Packing	15.18
	25	Valentine Resch	Supplies	12.75
	26	Geo. T. Sams & Co	do	24.86
	27	Sundry persons	Pay roll	700.00
	28	do	do	805.00
	29	do	do	1,605.67

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
Mar ...	30	Sundry persons	Pay roll	$982.16
	31	Big Muddy Coal and Iron Co	Coal	168.00
	32	Wm. O. Gibson & Son Grocer Co	Supplies	11.88
	33	Western Electrical Supply Co	do	13.60
	34	Sundry persons	Pay roll	682.84
Apr ...	1	John A. Eubanks	Services	75.00
	2	William Z. Howard	do	60.00
	3	Henry Buchterkirchen	Supplies	61.63
	4	Tiff Jenkins	Ice	8.57
	5	Frank L. Spring	Supplies	6.10
	6	Western Union Telegraph Co	Telegrams	2.06
	7	Anchor Line Store	Supplies	3.65
	8	F. Boeler	Sectional covering	35.80
	9	M. M. Buck Manufacturing Co	Supplies	40.26
	10	Chas. W. Barstow	do	4.60
	11	Buehler-Phelan Paint Manufacturing Co	do	8.58
	12	W. R. Colcord	do	5.08
	13	H. L. Ettman & Co	Sponges	2.00
	14	Geo. J. Fitz Foundry and Machine Co	Castings	46.76
	15	Huse & Loomis Ice and Transportation Co	Ice	20.20
	16	Missouri Car and Foundry Co	Lumber	10.29
	17	National Lead Co	Supplies	36.05
	18	Platt & Thornburgh Paint and Glass Co	do	18.93
	19	Simmons Hardware Co	do	1.70
	20	Western Iron and Supply Co	Valves	50.72
	21	Western Anthracite Coal Co	Coal	67.00
	22	Anchor Line Store	Supplies	5.08
	23	Broderick & Bascom Rope Co	do	14.97
	24	Berry Bros., Limited	Japan drier	.70
	25	H. L. Ettman & Co	Sponges	8.75
	26	A. M. Nelson Paint Co	Supplies	8.90
	27	Platt & Thornburgh Paint and Glass Co	Zinc	32.63
	28	Paddock-Hawley Iron Co	Iron	83.45
	29	J. D. Streett & Co	Supplies	65.94
	30	Buehler-Phelan Paint Manufacturing Co	do	8.13
	31	Christy Fire Clay Co	do	69.70
	32	Moffitt-West Drug Co	Oil	31.57
	33	J. D. Streett & Co	do	4.76
	34	Sundry persons	Pay roll	555.00
	35	do	do	1,296.20
	36	do	do	1,327.50
May ...	1	Edward Culver	Services	83.33
	2	Adolph J. Bentzen	Supplies	213.11
	3	Buehler-Phelan Paint Manufacturing Co	Yellow ocher	11.67
	4	Robert Freise	Milk	16.80
	5	Richard Garstang	Supplies	189.18
	6	Huse & Loomis Ice and Transportation Co.	Ice	23.04
	7	John Lowell	Supplies	424.84
	8	Missouri Car and Foundry Co	Lumber	262.24
	9	Frank Maree	Services	6.00
	10	National Lead Co	Supplies	150.34
	11	John O'Brien Boiler Works Co	do	19.46
	12	H. G. Vreeland & Son	do	6.15
	13	Bauer Grocer Co	do	515.73
	14	F. W. Brockman Commission Co	do	166.03
	15	Casper Stehle & Son	Looking-glasses	3.75
	16	F. Boeler	Sectional covering	144.82
	17	M. M. Buck Manufacturing Co	Supplies	283.24
	18	Bannantine Galvanized Iron Manufacturing Co.	do	32.44
	19	Bradlee & Co	Chain	521.76
	20	Wm. Barr Dry Goods Co	Supplies	29.75
	21	Samuel Cupples Woodenware Co	do	26.50
	22	D. Crawford & Co	do	14.10
	23	Drey & Kahn	Glass	8.69
	24	Flachman & Matthews	Supplies	53.56
	25	Richard Garstang	Repairs	33.50
	26	do	Supplies	235.00
	27	R. B. Gray China Co	do	7.30
	28	J. Kennard & Sons Carpet Co	do	76.60
	29	Jules C. Lachance	Painting	20.00
	30	Meyer Bros. Drug Co	Supplies	149.52
	31	Missouri Glass Co	do	30.78
	32	Monarch Rubber Co	do	72.41
	33	Paddock-Hawley Iron Co	do	100.54
	34	H. E. Piggott & Co	Iron	56.87
	35	Page & Tolkacz	Supplies	42.20
	36	Thos. Sexton Stove and Range Co	do	30.50
	37	N. M. Simonds	do	4.50
	38	St. Louis Electrical Supply Co	do	8.00

TABLE No. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
May ...	39	Simmons Hardware Co	Supplies	$52.03
	40	J. D. Streett & Co	do	98.84
	41	H. G. Vreeland & Son	do	63.55
	42	Western Brass Manufacturing Co	do	119.65
	43	Western Anthracite Coal Co	Coal	9.75
	44	Wieder Paint Co	Supplies	346.26
	45	Sundry persons	Pay roll	39.17
	46	Wm. Prufrock	Repairs	77.75
	47	Sundry persons	Pay roll	300.00
	48	do	do	1,387.50
	49	do	do	1,253.33
June ..	1	P. D. Cunningham	Services	25.00
	2	Adolph J. Bentzen	Supplies	137.87
	3	John Lowell	do	460.53
	4	Trorlicht-Duncker & Renard Carpet Co	do	286.88
	5	Day Rubber Co	do	5.90
	6	Michael Bennett	Repairs	45.00
	7	Jno. E. Bonecum]	Supplies	34.66
	8	Robert Freise	Milk	12.40
	9	John J. Ganahl Lumber Co	Lumber	48.88
	10	Ludlow-Saylor Wire Co	Wire	3.57
	11	Mermod-Jaccard Jewelry Co	Clock	6.50
	12	Missouri Glass Co	Supplies	1.20
	13	Platt & Thornburgh Paint and Glass Co	Paste	2.40
	14	Paddock-Hawley Iron Co	Supplies	31.71
	15	J. D. Streett & Co	Turpentine	14.94
	16	Thos. Sexton Stove and Range Co	Supplies	7.50
	17	Waters Pierce Oil Co	Oil	75.72
	18	Zittlosen Manufacturing Co	Flag	7.50
	19	Zwarts Homeopathic Pharmacy Co	Supplies	16.00
	20	A. G. Brauer	do	37.70
	21	Donnewald-Stephan Coal and Coke Co	Coal	17.00
	22	Excelsior Wire and Iron Co	Plate warmer	5.40
	23	Huse & Loomis Ice and Transportation Co.	Ice	63.26
	24	The Lammert Furniture Co	Supplies	99.71
	25	C. F. Liebke Hardwood Mill and Lumber Co.	Lumber	278.88
	26	Moffitt-West Drug Co	Supplies	7.04
	27	A. M. Nelson Paint Co	do	76.03
	28	Revere Rubber Co	Packing	11.20
	29	Jos. F. Schelbrinck	Supplies	12.95
	30	St. Louis Transfer Co	Hauling	8.43
	31	Western Iron and Supply Co	Supplies	12.59
	32	M. M. Buck Manufacturing Co	do	597.93
	33	Simmons Hardware Co	do	192.81
	34	Branch-Crookes Saw Co	Saws	54.20
	35	Fairbanks, Morse & Co	Supplies	7.11
	36	R. B. Gray China Co	do	7.80
	37	Stix, Baer & Fuller	Sheets	34.20
	38	Von der Au-Cluss Hardware and Cornice Co.	Saws	2.90
	39	Albert Waycott & Co	Supplies	9.86
	40	Western Brass Manufacturing Co	do	2.63
	41	Wrought Iron Range Co	do	6.32
	42	Valentine Resch	do	8.66
	43	Arrow Boiler Compound Co	Boiler compound	137.80
	44	F. Bocler	Sectional covering	210.13
	45	Broderick & Bascom Rope Co	Supplies	487.59
	46	Interstate Oil Co	Oil	1.00
	47	Monarch Rubber Co	Packing	12.33
	48	Leonard & Ellis	Oil	18.00
	49	L. M. Rumsey Manufacturing Co	Supplies	22.81
	50	Simmons Hardware Co	do	89.04
	51	Scruggs, Vandervoort, and Barney Dry Goods Co.	do	368.34
	52	Western Electrical Supply Co	do	21.03
	53	Anchor Line Store	do	397.37
	54	Cairo City Coal Co	Coal	48.80
	55	Eau Claire-St. Louis Lumber Co	Lumber	132.58
	56	The Laclede Power Co	Supplies	20.14
	57	Missouri Car and Foundry Co	do	59.60
	58	N. O. Nelson Manufacturing Co	do	13.46
	59	Paddock-Hawley Iron Co	do	20.41
	60	Cairo City Coal Co	Coal	72.00
	61	L. Kney	Meat	51.76
	62	Matt Monaghan & Co	Supplies	60.55
	63	Pittsburg Coal Co	Coal	180.00
	64	Valentine Resch	Supplies	6.30
	65	Simmons Hardware Co	do	12.02
	66	Walter & Rust	do	33.87
	67	A. B. Bowman	Lathe	240.65

TABLE NO. 1.—*Detailed statement of expenditures made in connection with the work of removing obstructions in Mississippi River, etc.*—Continued.

Date.	Voucher.	To whom paid.	For what paid.	Amount.
1897.				
June...	68	Adolph J. Bentzen	Supplies	$131.41
	69	M. M. Buck Manufacturing Co	.....do	108.30
	70	.....do	.....do	5.22
	71	Consolidated Coal Co. of St. Louis	Coal	65.00
	72	Wm. Freese	Supplies	34.41
	73	Robert Freise	Milk	6.00
	74	Huse & Loomis Ice and Transportation Co.	Ice	53.00
	75	Western Union Telegraph Co	Telegrams	1.40
	76	John Lowell	Supplies	132.41
	77	F. Bocler	Sectional covering	16.64
	78	Sundry persons	Pay roll	300.00
	79	.....do	.....do	1,623.34
	80	.....do	.....do	206.00
	81	.....do	.....do	1,368.00
		Total expended		83,421.64

TABLE NO. 2.—*Summary of expenses for operating U. S. snag boats H. G. Wright and J. N. Macomb, in connection with the work of removing obstructions in Mississippi River during fiscal year ending June 30, 1897.*

Application.	1896.					
	July.	August.	September.	October.	November.	December.
Office expenses	$353.00	$500.20	$356.00	$502.88	$359.49	$304.31
Expenses of snag boat H. G. Wright:						
Crew	1,678.43	1,461.82	2,189.76	2,181.17	2,141.00	2,165.00
Outfit			17.65	164.22	7.50	85.20
Fuel	48.00	198.80	416.80	587.50	1,364.00	638.85
Subsistence	55.25	520.86	514.67	532.18	533.47	578.41
Supplies	11.15	23.62	335.38	341.76	26.99	298.68
Repairs		39.69	28.06	78.61	25.00	157.81
Miscellaneous	1.00			2.10		
Expenses of snag boat J. N. Macomb:						
Crew	1,275.67	1,770.00	2,149.00	2,149.17	2,155.00	2,152.00
Outfit	16.40	8.20	35.58	2.20		
Fuel		104.39	1,198.00	924.70	929.75	960.00
Subsistence	56.16	494.00	729.08	758.33	251.40	791.87
Supplies	169.23	35.77	88.70			
Repairs	4.70	2.70		178.34		
Miscellaneous				2.10		
Total	3,673.99	5,250.05	8,058.68	8,405.26	7,793.60	8,132.13

Application.	1897.						
	January.	February.	March.	April.	May.	June.	Total.
Office expenses	$358.51	$358.32	$308.21	$557.06	$300.00	$326.40	$4,584.38
Expenses of snag boat H. G. Wright:							
Crew	2,148.00	2,142.00	1,629.34	1,431.20	1,381.83	1,368.00	21,917.55
Outfit		2.10		.50	563.52	575.28	1,415.97
Fuel	809.61	440.70	435.20				4,930.46
Subsistence	685.30	526.72	263.34	10.00	691.98	492.58	5,404.76
Supplies	112.50	107.10	42.43	51.43	318.32	648.41	2,317.77
Repairs	8.22	72.87	14.35	819.22	1,088.35	508.66	2,340.84
Miscellaneous						8.43	16.53
Expenses of snag boat J. N. Macomb:							
Crew	2,155.00	2,155.00	1,903.83	1,327.50	1,387.50	1,919.34	22,499.01
Outfit	15.60			14.46	289.80	1,368.65	1,750.79
Fuel	955.56	720.00	760.20	67.00	9.75	372.80	7,092.15
Subsistence	864.74	99.10	353.83	86.50	567.57	699.85	5,852.43
Supplies	138.53			14.34	218.57	618.28	1,283.42
Repairs	22.75		12.75	199.05	913.89	670.30	2,004.48
Miscellaneous							2.10
Total	8,274.22	6,623.91	5,723.48	4,078.26	7,831.08	9,576.98	83,421.64

W 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

The object of the improvement is to obtain eventually a minimum depth at standard low water of 6 feet from the mouth of the Missouri River to St. Louis, a distance of 16 miles, and of 8 feet at the same stage of water from St. Louis to the mouth of the Ohio River, 178 miles, the natural depth being in many cases from 3½ to 4 feet. The channel is divided at a number of points by islands forming sloughs and secondary channels behind them, through which a large portion of the volume of the flow is diverted, to the detriment of navigation.

The initial point of the work for the lower portion is St. Louis, the programme being to make the work continuous, proceeding downstream from that city.

The first work for improvement began in 1872, and was continued for a number of years as appropriations were made, the works consisting of dikes and dams of brush and stone, erected with a view to confining the low-water volume to one channel, and of revetments to hold and preserve the banks where necessary or advisable.

Under these appropriations work of this character was done at the following localities between the mouth of the Ohio and the mouth of the Illinois River, viz: Piasa Island, Alton Harbor, Sawyer Bend, St. Louis Harbor, Arsenal Island, Horsetail Bar, Carroll Island, Port Chartres, Turkey Island, Kaskaskia Bend, Liberty Island, Devils Island, and in the vicinity of Cairo, Ill.

The present project is a continuation of the plan adopted in 1881, and contemplates a reduction of the river to an approximate width of 2,500 feet below St. Louis, the natural width being in many cases from 1 to 1½ miles. The method employed is the building up of new banks out to the line desired from the solid matter brought down by the river, and which is collected by means of hurdles. The banks, both new and old, are revetted where necessary. Other means are also used occasionally for completing or hastening the depth required.

A hurdle, as the term is here used, is one of many silt-arresting devices that have been experimented upon in this country and elsewhere. The hurdle consists, essentially, of a row or of parallel rows of piling, the piles driven either singly or in clumps, the piling being connected lengthwise of the hurdle by wattling of fine brush or by curtains composed of brush and lodged against the upstream side of one of the rows of piles, the whole forming a permeable dike through which the silt-laden current can pass, though with greatly diminished velocity, resulting in deposits of silt above and below the hurdles.

These deposits are generally soon overgrown with willows or cottonwood, and after they arrive at sufficient height they can be revetted on their river fronts.

To guard against loss by scour of the piles, a broad flexible mattress is first sunk on the line of the hurdle. Through this mat the piles and clumps of piles are driven.

During the past year the hurdles have been constructed of clumps of piles, three piles and upward to each clump. These piles are driven so that when their upper ends are drawn together by means of a wire rope they form a sort of pyramidal structure, the horizontal distances of the piles from each other at the surface of the river bed being 8 to 10 feet, depending mainly upon the depth of the water.

The wire ropes are made on the work; they are composed of 14 to 18 strands of No. 14 galvanized-iron wire. They are drawn taut by means of the pile-driver machinery. At each turn of the rope around the upper end of the clump of piles a spike is driven as an additional guard against the rope slipping, though the wire itself generally binds or cuts into the piling sufficiently to prevent any slip. This method of drawing the upper ends of the piles together appears to be better than the old one of bolting them.

The tops of the piles are generally at an elevation of 20 feet above extreme low water, excepting that in the curtain or wattling row the top of one pile of the clump is at an elevation of about 25 feet above that stage, in order to intercept drift at high stages and prevent it from crossing the line of hurdle and dragging the top of the latter with it.

The curtain or wattled row is braced by vertical diagonal braces heeled against a row of clumps spaced at such distances below as to make the angle of the braces about 45°.

The heel of the brace is held by a clevis passing around one of the piles of the lower clump, with its pin through the brace. At top the brace is bolted to one or more of the piles in the upper clump.

The piling of the hurdle row is so spaced as to represent an equivalent of one pile to the linear foot of hurdle. The piles are driven by means of the hydraulic jet as well as by the hammer, the latter weighing 2,400 pounds, and sometimes by both combined.

The completed curtain, or the wattling, whichever may be used, is generally carried finally to a height of 20 feet above extreme low water. The mattress is from 60 to 135 feet in width, depending upon the depth of water and consequent length of piles, as well as upon liability of the bed to suffer from scour. It is fabricated upon floating ways, in place, by wattling brush upon poles spaced about 5 feet apart and in any length desired. Continuity is obtained by lapping the poles and fastening them together with spikes and wire. When additional strength is required, wire cables are used across, and in the direction of the length of the mattress. The brush is spiked to the poles at the edges of the mattress and at other points, about one spike to every third pole. In sinking the mat a little less than 1 cubic yard of broken rock is required to a cord of brush.

The piles used in the hurdles run in lengths from 25 to 60 feet, and their average penetration in the bottom is about 15 feet. They are driven with the large end down.

At the shore end of the hurdle the bank is revetted for about 300 feet, of which 200 feet is below the axis of the hurdle.

In constructing the shore revetment a mat about 120 feet or more in width, its inner edge at the surface of standard low water, is sunk. The bank is then eventually graded to a slope of one-half and covered with riprap. Where necessary to grade the bank by artificial means, the grading is done by the hydraulic method or by means of shovels, etc.

Since the adoption of this project work has been done at the following localities, by methods substantially as above described, viz: Piasa Island, Alton Harbor, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail Bar, Carroll Island, Twin Hollows, Pulltight and Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Cornice Island, Calico Island, Michaels Landing, Rush Tower, Fort Chartres, Crooks Landing, Turkey Island, Ste. Genevieve, Liberty Island, Minton Point, Cape Girardeau, Powers Island, and vicinity of Cairo.

Since last annual report works looking to the permanent improvement of the river have been carried on in the following localities, viz: Sulphur Springs, Michaels Landing, Rush Tower, Ste. Genevieve, Chester, Liberty and Powers Island. Work in the nature of portable jetties and dredging for the temporary improvement of the channel was done in the following localities: Chain of Rocks, Harrisonville, Calico Island, Turkey Island, Ste. Genevieve, Seventy-Six Landing, Grand Tower Bend, Scheneimans, Goose Island, and Hackers Bend.

Sulphur Springs.—This locality commences about 13 miles below St. Louis and extends down 4 miles.

The work done here was confined to the east side of the river and consisted of repairs, extensions, and additions to the hurdles already in place, equivalent in the aggregate to 990 feet of new hurdle. The location and extent of this work is shown upon Pl. I herewith.

Michaels Landing (27 miles below St. Louis).—This point is the commencement of a series of works extending down the river about 9 miles, covering what is known as the Rush Tower Reach.

No. 1 hurdle of this series was broken last season by a loaded coal barge going through it after the tornado of May 27, 1896. The breach was enlarged to 750 feet during the high stages of last winter and this spring. The construction of a new hurdle, No. 2, in rear of this opening and the repairs to No. 1 were commenced on the 8th of June, this fiscal year, and are now in progress. No. 2 hurdle is 2,800 feet in length, of the ordinary type, and is nearly completed. The location and extent of this work are shown upon Pl. II, and material used and work done on this and other works mentioned are given in the tables devoted to these subjects to be found in the report of Assistant D. M. Currie, herewith.

Rush Tower.—The bank protection placed in the years 1893 and 1894 between Osborne Field and Durfees Landing, 38 miles below St. Louis, had never been completed to high water. The bank above the revetment had been eroded back until there was danger of the work being destroyed. Wherever this danger was most imminent additional rock was used to repair breaks and carry the revetment farther up the banks.

Ste. Genevieve.—The reach of the river under improvement in this locality extends from Little Rock, Mo., 47 miles below St. Louis, to near the mouth of the Kaskaskia River, 7 miles below.

One hurdle on the Illinois side of the river was repaired, and four on the Missouri side extended to their projected lengths. Some work was done on the head of Stanton's tow-head for the purpose of protecting it from erosion. The location of this work is shown upon Pl. III herewith.

Chester, Ill. (73 miles below St. Louis).—The river and harbor act of June 3, 1896, contained a mandatory clause requiring that "$30,000 or so much thereof as may be necessary shall be expended in removing the bar in front of Chester, Ill., and protecting the west bank of the Mississippi River opposite Chester." The work done in compliance with this law consisted in revetting the bank opposite Chester as far as the funds available would permit. The work was commenced September 8 and completed for the season October 27, 1896. The mattress used for the protection of the foot of the bank below low water was of the usual type, 125 feet wide. The protection was commenced at the old railroad incline in Clearyville and extended downstream 3,310 feet. The rock revetment was carried up the slope of the bank a distance of about 10 feet above low water. The last high water has graded the upper bank to a proper slope for continuing this revetment. The funds remaining will be sufficient to carry this up to about the 20-foot contour. The location and extent of this work is shown upon Pl. IV herewith.

Liberty.—This reach of the river commences at Waters Landing, 79 miles below St. Louis, and extends about 6 miles downstream.

The work done here consisted in extending to completion four hurdles under construction at the commencement of the year and building an additional one. The east bank of the river, known as Liberty Bend, has been for some time subjected to very rapid erosion. The bank is high, consisting of sand and loam under which lies a stratum of quicksand, all of which makes it very difficult to protect from the erosive action of the water. At a point near the upper end of the bend a strong hurdle dike about 700 feet in length was built out from the bank to prevent the flanking of the revetment. Under the protection of this the revetment was commenced and extended downstream for a distance of 6,850 feet. The average width of the subaqueous mattress was about 130 feet. The above low-water revetment was carried up to the 20-foot stage along the upper 4,450 feet, then gradually down to the 14-foot stage on the next 800 feet, and continued at that height from thence to the end. In order to hold this bank it will be necessary to extend the revetment farther downstream and carry it up to a higher stage all along its entire length.

Powers Island.—This reach extends from Commerce, Mo., 143 miles below St. Louis, downstream about 7 miles. Within this reach are located what is known as "Jacket Pattern" and "Goose Island" shoals, localities that have given great trouble to navigation. The river here is excessively wide, and much of the water passes down sloughs behind islands or is spread out over sand bars.

Doolans Slough, which separates Powers Island from the main Missouri shore, is estimated to carry off about one-half of the low-water discharge of the river and cause much of the trouble experienced on the Goose Island and Jacket Pattern shoals.

The work of closing this with a permeable hurdle dam was commenced July 9 and finished September 9, 1896. The dam was located nearly 2 miles below the head of Powers Island and 4 miles below Commerce, across a narrow part of the chute where there is a width of only 1,600 feet and where the banks are firm and the cross section regular.

The type of construction was that of the ordinary pile hurdle, but with material for three hurdles massed in one. The foundation for the dam was the ordinary continuous mattress 150 feet wide, two-thirds of the width lying below the piling. On the top of this was another mat 50 feet wide, and in deep water third and fourth tier mattresses 25 feet wide, laid just below the main row of piling to reenforce them and build up the bottom to something like an even cross section and receive the overfall of the dam.

The bank at each end of the dam was protected by mattresses 600 feet long by 125 feet and 150 feet wide on the east and west sides, respectively, and extending 250 feet above and 350 feet below the structure.

The banks were graded from the edges of these mattresses at low water to their tops to a slope of 1 on 2. Over this was laid a revetment of stone. Some settling took place in this revetment during the fall and winter, which was easily repaired.

The effect of closing this slough was very manifest during the low water of last fall, when but little or no trouble was experienced in these shoal places in the main channel, which had heretofore always given trouble at that season.

TEMPORARY EXPEDIENTS.

In my last annual report a brief description was given of a jet dredge boat then in process of construction. This boat was completed and commenced operations about September 1, on the approach of low water. From this date until the end of October, when the river commenced to rise, it was in commission. Work was done by it at Harrisonville Crossing, Calico Island, Stantons Towhead, Grand Tower Bend, and Schenimans. At all of these localities the channel was materially improved by its operations, the depths being increased from 1 to 3 feet. This outfit consisted of the dredge boat, a quarter boat, a pile driver, a barge with supply of coal and piles, and one of the steam tenders. The dredge was furnished with a double crew during a part of the time that it was in service, in order that it might be operated night and day. The cost of the dredge alone, not including the original cost of the barge and two pile driver hoisting engines obtained from our plant, was $18,001.54.

The average cost per month of this dredge with its attendant outfit was approximately $2,650. A tracing showing the arrangement of the machinery upon this dredge and its method of operation is forwarded herewith.

The discharge pipes from the jet pumps on the towboat *Gen. H. L. Abbot* were changed so as to deliver at the stern of the boat instead of the bow as originally arranged, and two spuds were added near the bow. By this arrangement the boat could go on a bar, head upsteam, drop the spuds, work her wheel and the jet pumps, and soon make a material increase in the depth of water. Working in this manner this boat was able to give valuable assistance at short shoals.

Portable jetties.—During the past two low-water seasons experiments have been made with cheap devices designed to concentrate the water at shoal places and by increasing its velocity induce a scour that will give a depth of channel sufficient for the pressing needs of navigation, these devices to be removed as soon as they have effected their object or the river has risen.

The results obtained last season were very gratifying and have led to the adoption of a system which may be briefly described as follows: Having determined upon the direction that should be given to the jetty in order to produce the best results and admit of the easiest possible construction, piles are driven firmly into the bed of the river along this line at distances apart varying from 10 to 20 feet, depending upon the depth of water and the strength of current. In extreme cases, instead of single piles clumps of two or three may be driven. Along these piles at a proper distance above the water surface other piles are made fast longitudinally either by wire or rope. These are to support the upper ends of corrugated sheet-steel panels, the lower end of which is to rest upon the bottom of the river. Each panel is 10 feet in width, measured in the direction of the jetty, and from 10 to 20 feet long, depending upon the depth of water in which it is to be used. It is made of No. 14 United States standard gauge corrugated sheet steel, riveted to three 5-inch I-beams, 12.50 pounds per foot. Suitable links or clevises are provided for handling the panels. To prevent scour taking place along the lower edge of the panels, and thus permitting them to swing through between the piles, a mattress from 8 to 10 feet wide is made by placing small fascines side by side. This is tied to the lower edge of the panels and sunk with rocks. The method of constructing these jetties is shown upon the tracing forwarded herewith.

At the end of the low-water season the jetties are removed. The panels are taken up, cleaned, painted, and stored. The piles are also removed to be used in future work.

During the low-water season portable jetties were constructed and removed in the following localities: Turkey Island, 1,150 feet; Ste.

Genevieve, 1,460 feet; Seventy-six Landing, 750 feet; Schenimans, 1,000 feet; Goose Island, 850 feet, and Hackers Bend 1,350 feet, making in all 6,560 feet. The field expenditures for this work were as follows:

Labor, $8,865.14; subsistence, $1,865.16; piles (not recovered), $1,139.35; stone, $110.40; rope, $900; wire, $148.20; spikes, $12; lumber, $27.66; coal, $1,072.86; miscellaneous, $300.56; panels (not recovered), $1,359.92; total, $15,801.25, equal to $2.41 per linear foot. Add to this the proportionable expenses for plant, repairs, deterioration, towage, office, engineer depot, etc., which amounts to $13,049.06, or $1.99 per linear foot, the total cost was $28,850.31, or $4.40 per linear foot.

The cost of the piles and panels not recovered was $2,499.27, an average of 38 cents per foot. Had these been recovered the total cost per linear foot would have been $4.02.

If the jetties had been abandoned and no attempt made to recover any of the material the cost would have been: Labor, $5,789.29; subsistence, $1,225; piles, $3,632; stone, $110.40; rope, $900; wire, $148.20; spikes, $12; lumber, $27.66; coal, $704; miscellaneous, $268.56; panels, $18,378.10; total, $31,250.21. Add to this $8,500, the proportionate other expenses chargeable to this work, the total cost will be $39,750.41, or $6.06 per linear foot.

During the season about 11 per cent of the recoverable material was lost.

In each of the localities where jetties were constructed, except Seventy-six Landing, their effect was hastened by the aid of No. 1 jet dredge or the steamer *Gen. Abbot.* The channel depth was increased from 1 to 3 feet, as follows: At Turkey Island, 2¾ feet; Ste. Genevieve, 1 foot; Seventy-six Landing, 2 feet; Schenimans, 3 feet; Goose Island, 1½ feet, and Hackers Bend, 1 foot. These increases are after allowance has been made for differences in the stage of water. The least channel depth at any of these localities when the jetties were removed was 8 feet.

The foregoing facts and figures fully demonstrate that it is practicable, within reasonable limits of expense, to maintain a navigable channel 6 feet in depth at all stages of water between St. Louis and the mouth of the Ohio River by means of portable jetties, aided by dredges, provided that the permanent contraction works now in process of construction be maintained and proceeded with; and there is every reason to believe that a channel depth of 8 feet can be maintained by these means when the whole reach of the river has been permanently contracted within the limits contemplated in the project for its general improvement.

There is now in store and ready for use sufficient corrugated steel panels to construct 9,000 feet of portable jetty or sufficient for nine jetties, each 1,000 feet in length. A party and outfit on the ground with the material should put this in place at the rate of 400 feet per day.

Hydraulic dredge No. 2.—With the view to giving the greatest relief possible to navigation during the approaching low-water season by temporary expedients, authority was obtained from the Chief of Engineers, June 12, 1896, to construct a second hydraulic dredge, making use of such parts of the plant belonging to the work as could be made available.

One of the most recently constructed model barges used for transporting stone was selected and given such additional strength by bulkhead timbers as was necessary to enable it to sustain the heavy machinery to be placed upon it without vibration when in motion. This barge is 135 feet long, with 28-foot beam, and has a 6-foot depth of hold. On it was placed a 20-inch centrifugal pump, actuated by a horizontal compound condensing engine, connected directly with the pump shaft. Diameter of high-pressure engine, 11 inches; diameter of low-pressure engine, 25 inches, with 18-inch stroke. The pump and engine are upon the same cast-iron base. This machinery was purchased from Edwards & Co., New York. Steam is furnished by three boilers, Mississippi River type, 48 inches diameter and 28 feet long, each having five flues 11 inches in diameter. The ordinary working steam pressure of the boilers is 140 pounds. The engines make 200 revolutions per minute and the pump discharges about 2,000 cubic feet of material. On the basis that 10 per cent of this is sand, which is a very reasonable estimate, the dredge will excavate about 450 cubic yards per hour. The suction pipe is 20 inches in diameter from the pump out to the bow of the boat.. At this point the pipe branches to the right and left, with a quarter turn 15 inches in diameter. At the ends of these is a stuffing box and another quarter turn, which permits the pipe to extend down over the bow of the boat and into the water. These stuffing boxes allow each branch of the pipe to move in a vertical plane. At their lower ends these pipes separate by Ys into two branches, each 12 inches in diameter, and terminate in nozzle pieces with opening 30 inches by 6 inches. The two 15-inch pipes are tied together by suitable bracing and raised and lowered by means of a derrick with boom extending out beyond the boat. The hoisting power is obtained from a pile-driver engine taken from the plant. The same engine is used to haul the dredge ahead and keep it up to its work.

Immediately at the pump the discharge pipe makes a quarter turn and is enlarged to 24 inches in diameter. It passes back through the boat and over the stern on to flatboats, which support it for a distance of 500 feet. At the stern of the boat there is an S-shaped piece in the pipe having a horizontal swivel joint, which permits the discharge to be made in any horizontal direction. Where the pipe passes from one flat to another there is a short piece of para rubber hose which permits a flexible motion. The flatboats on which this pipe is supported are a part of the outfit of the plant used for low-water revetment. In the discharge pipe near the pump there is a priming valve used when starting the pump.

To operate the dredge piles are driven on each side of the channel to be opened and at some little distance from it lines are made fast to these and the dredge and discharge pipe maneuvered by means of them.

This dredge was not completed until the end of November, about the time the river commenced to rise. There was no opportunity to give it a practical test upon a channel bar, but it was operated experimentally for several days and all its parts thoroughly tested. It bids fair to be a very satisfactory machine. Its cost was $21,705.76.

Hydraulic dredges Nos. 3 and 4.—The dredges Nos. 1 and 2 above described are what may be termed temporary expedients, constructed hastily to meet the urgent requirements of low-water navigation during last season. With the object of obtaining a more permanent plant of this kind and to comply with the provisions of the river and harbor act of June 3, 1896, a thorough study of the subject of dredging as applied to river bars was made. This has resulted in a type of dredge of large capacity and light draft, which is easily handled, has ample accommodations for its crew, and at the same time can readily dispose of its own dredged material beyond the lateral limits of the channel to be improved.

The main features of the dredge may be briefly described as follows:

The hull to be made of steel throughout and to be 160 feet long, 40 feet beam, and 6 feet 6 inches depth of hold. There is an opening or well at the bow, in which the suction pipes are placed, 24 feet wide at forward end, 18 feet at after end, by 34 feet long. The two projecting ends thus formed are tied together by a box girder.

There are two centrifugal pumps with suction and discharge openings 20 inches in diameter. The discharge pipe is immediately enlarged to 24 inches in diameter. The pumps are single suction, with interior lining capable of being conveniently removed when worn.

Each pump is driven by a horizontal noncondensing compound direct-connected engine, 15-inch high pressure, 26-inch low pressure, with 18-inch stroke, capable of developing 300 actual horsepower, with approximately 200 revolutions per minute, under a boiler pressure of 140 pounds per square inch, and maintaining, through the suction and discharge pipes, the velocity necessary to carry at least 20 per cent of sand with 80 per cent of water through 500 feet of discharge pipe.

The steam is to be supplied by 6 boilers of the Mississippi River steamboat type, each 48 inches in diameter and 28 feet long, and containing 5 flues each 11 inches in diameter. The boilers are arranged in two batteries of three each, capable of being worked separately or together.

With each main pump there is a jet pump for applying water under pressure through nozzles to the sand at the entrance to the suction pipes. The jet pumps are of the Worthington type, with compound engines capable of delivering 1,200 gallons per minute against a pressure of 65 pounds.

The suction pipe of each main pump has a diameter of 20 inches. It leaves the pump by a reverse curve, passes out through the hull and by a radial joint down through the suction well and terminates with a nozzle or suction head 10 feet wide and 20 inches high, and provided with screen bars or lobes. In order to present the opening in the most favorable manner to the sand the suction head is slightly curved.

There is one discharge pipe for each main pump. At the stern of the dredge there is in each pipe a reverse-curve swivel joint, by means of which the pipe beyond the dredge is slightly raised and can be changed in direction through an angle of 180 degrees. On the outside of the dredge the discharge pipes are in lengths of 24 feet connected by flanges; each two of such lengths are connected by a coupling and piece of flexible rubber hose. The pipes are supported every 25 feet upon steel pontoons so arranged that they may swing under the pipe and present their narrowest dimensions to the current. Each discharge pipe is 500 feet in length and terminates with a baffle plate, for the purpose of steadying the pipe line while the material is going through it.

Cabin accommodations are provided for a double crew consisting of 50 officers and men.

The electric-light plant consists of two 2,000-candlepower arc lights, one 4,000-candlepower focussing headlight with reflector, seventy-five 16-candlepower incandescent lamps, with the necessary engine, dynamo, switch board, and other appurtenances and appliances for a complete first-class outfit. All other outfit and appliances necessary to a complete dredge are provided.

When occasion requires it is intended that the dredge shall be in operation night and day. The output per hour will be 600 yards or 1,200 yards for the dredge.

Four sheets of drawings showing the main features of the dredge are forwarded herewith.

After the plans and specifications for this dredge had been prepared proposals for constructing two were advertised for February 6, 1897. The bids received were opened March 8, 1897. The lowest of these being The Bucyrus Company, South Milwaukee, Wis., in $204,800 for both, a contract was entered into with them March 17, 1897. The dredges are to be completed on or before October 10, 1897. Satisfactory progress is being made with their construction.

Plant.—The plant pertaining to this work was kept in good state of repairs during the year and rendered efficient service. There are 16 of the barges used for transporting stone, brush, and other material that have been in constant service for fourteen years. They are practically beyond repair and will have to be replaced by new ones after one more season's work. One or two new towboats will also be needed for carrying on the dredging operations.

Surveys and investigations.—During the year a resurvey of the river has been made at the low-water stage from Red Rock, Mo., 87 miles below St. Louis, to the mouth of the Ohio. This has been plotted to a scale of 1:100,000. A tracing from the map is forwarded herewith. The details connected with this survey, together with the physical data relating to the Mississippi River between the mouth of the Missouri and the mouth of the Ohio rivers, collected since last annual report, may be found in the report of Assistant John O. Holman, which is also forwarded.

Mr. D. M. Currie has continued to discharge the duties of principal assistant engineer upon the work and Mr. William S. Mitchell and Mr. Gerald Bagnall those of assistants in charge of the large field parties. The procuring of brush and quarrying of stone by hired labor was done by parties in charge of Mr. E. D. Libby, assistant engineer. The engineer depot, at which a large part of the supplies for the work is assembled and distributed and repairs to tools and minor repairs to the floating plant are made, has continued in charge of Superintendent C. D. Lamb. All these gentlemen have satisfactorily discharged their several duties.

For further details concerning the operations of the year reference is invited to their reports, which are herewith transmitted.

ESTIMATE.

The original estimate of the cost of the improvement of the Mississippi River between the mouth of the Ohio and the mouth of the Missouri River, as revised in 1883, is $16,397,500.

The aggregate amount of the funds appropriated and made available for this work to June 30, 1897, is $7,853,333.32.

The total appropriations for this work to date amount to $8,033,333.32. Of this amount $180,000 was allotted by acts and projects for improvement between the Illinois and the Missouri rivers, including Alton Harbor, leaving a balance of $7,853,333.32, as stated above, to be applied to the project for the general improvement of the river between the mouth of the Missouri and the mouth of the Ohio River.

Of this amount there was on hand June 30, 1897, an available balance of $780,566.82, exclusive of outstanding liabilities. The amount that has been expended on the project to this date is therefore $7,072,766.50.

The amount expended during the fiscal year ending June 30, 1897, is $499,325.48.

This available balance includes the balances unexpended from special allotments made by Congress, as follows:

For bank protection at Cairo, Ill., act of July 5, 1884	$8,600.00
For continuing improvement at Cape Girardeau, Mo., act of August 5, 1886	22,500.00
For bank protection on east side of Mississippi River opposite to mouth of Missouri River, act of June 3, 1896	50,000.00
For removing bar in front of Chester, Ill., and protecting west bank of river opposite Chester, act of June 3, 1896, $30,000; balance unexpended	6,155.82
Total	87,255.82

The river and harbor act of June 3, 1896, provides that contracts may be entered into and material purchased and work done otherwise than by contract for the section of the Mississippi River between the mouth of the Ohio and the mouth of the Missouri River for the fiscal year ending June 30, 1897, not to exceed in amount $325,000.

From this amount, when it becomes available, it is expected to pay for the two steel-hulled hydraulic dredges, now contracted for and in process of construction, and for stone and piles to be used in contraction works and revetting the banks also contracted for. The full amount of this $325,000 may be used in discharging the obligations of these contracts.

The balance of the estimate for the original project not appropriated June 30, 1897, is $8,544,166.68.

It is estimated that the sum of $800,000 can be profitably expended during the fiscal year ending June 30, 1899, in the work of the original project and in the temporary work required by the river and harbor act of June 3, 1896.

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ended June 30, 1897, amounted to $1,139,723.86. The amount of internal revenue collected was $6,825,959.28.

Money statement.

July 1, 1896, balance unexpended		$608,511.08
Amount appropriated by sundry civil act approved June 4, 1897		673,333.33
		1,281,844.41
June 30, 1897, amount expended during fiscal year		499,325.48
July 1, 1897, balance unexpended		782,518.93
July 1, 1897, outstanding liabilities	$1,952.11	
July 1, 1897, amount covered by uncompleted contracts	(*)	
		1,952.11
July 1, 1897, balance available		† 780,566.82
Amount (estimated) required for completion of existing project		8,544,166.68
Amount that can be profitably expended in fiscal year ending June 30, 1899		800,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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* The river and harbor act of June 3, 1896, authorized contracts to be entered into and work to be done to the amount of $325,000. Under this authority contracts have been entered into as per table herewith, which will consume this entire amount. At the end of the fiscal year the amount had not been appropriated.

† Of this balance special allotments have been made by Congress as follows:

Bank protection at Cairo, Ill., act July 5, 1884 (balance)	$8,600.00
Continuing improvement at Cape Girardeau, Mo., act of August 5, 1886 (balance)	22,500.00
Removing bar in front of Chester, Ill., and protecting west bank of river opposite Chester, act of June 3, 1896 (balance)	6,155.82
Bank protection on east side Mississippi River opposite mouth of Missouri River, act of June 3, 1896	50,000.00
Total	87,255.82

List of appropriations.

By act of—		By act of—	
June 10, 1872	$100,000.00	August 5, 1886	$375,000.00
March 3, 1873	200,000.00	August 11, 1888	300,000.00
June 23, 1874	200,000.00	September 19, 1890	400,000.00
March 3, 1875	200,000.00	July 13, 1892	525,000.00
August 14, 1876	200,000.00	March 3, 1893	658,333.33
June 18, 1878	240,000.00	August 18, 1894	758,333.33
March 3, 1879	200,000.00	March 2, 1895	758,333.33
June 14, 1880	250,000.00	June 3, 1896	275,000.00
March 3, 1881	600,000.00	June 4, 1897	673,333.33
August 2, 1882	600,000.00		
July 5, 1884	520,000.00	Total	8,033,333.32

Abstract of proposals for piles received in response to advertisement of March 2, 1897, and opened March 22, 1897, by Maj. Thos. H. Handbury, Corp of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	First-class piles (price per foot).				Amount.
		3,200, 36 to 40 feet.	2,400, 41 to 45 feet.	1,600, 46 to 50 feet.	800, 51 to 65 feet.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	
1	George Wolf, Grand Tower, Ill					
2	John H. Crowder, Commerce, Mo	10½	10½	10½	10½	$36,540.00
3	P. S. McCann, Grand Tower, Ill	12½	12½	12½	12½	43,500.00
4	Fred. Hartweg, Cincinnati, Ohio	10¾	10¾	10¾	10¾	37,410.00
5	H. A. Russell, St. Louis, Mo					

No.	Name and address of bidder.	Second-class piles (price per foot).						Amount.
		400, 25 to 30 feet.	1,600, 31 to 35 feet.	2,000, 36 to 40 feet.	2,000, 41 to 45 feet.	1,200, 46 to 50 feet.	800, 51 to 65 feet.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	
1	George Wolf, Grand Tower, Ill	7⅝	7⅝	7⅝	7⅝	7⅝	7⅝	$25,147.25
2	John H. Crowder, Commerce, Mo	6	6	6	6	6	6	19,788.00
3	P. S. McCann, Grand Tower, Ill	7½	7½	7½	7½	7½	7½	24,735.00
4	Fred. Hartweg, Cincinnati, Ohio	6½	6½	6½	6½	6½	6½	21,437.00
5	H. A. Russell, St. Louis, Mo	6	6	6	6	6	6	19,788,00

Acceptance recommended of bid No. 2 for first-class piles, and bid Nos. 2 and 5 for second-class piles.

Abstract of proposals for stone, received in response to advertisement dated March 2, 1897, and opened March 22, 1897, at 12 o'clock noon, by Maj. Thos. H. Handbury, Corps of Engineers, at St. Louis, Mo., for work of improving Mississippi River between mouths of Ohio and Missouri rivers.

No.	Name and address of bidder.	Quantity offered.	Price.	Amount.	Remarks.
		Cu. yards.	*Cents.*		
1	Wm. G. Allison and Sab. Oliver, Chester, Ill.	40,000	39	$15,600	1 bid only received. Landing 1 mile above Chester.
2	Bussen Bros., St. Louis, Mo	10,000	50	5,000	Landing Quarantine, Mo.
3	Earl E. Burke, Neeleys Landing, Mo.	20,000	48	9,600	Landing near Neeleys, Cape Girardeau, Mo.
4	Nelson Sisson, Grand Tower, Ill.	10,000	51	5,100	Landing opposite Grand Tower, Ill.
5	Wm. C. Swanwick, Chester, Ill	30,000	39$\frac{9}{10}$	11,970	Landing Menard, Randolph County, Ill.
6	Bennett James, Mitchie, Ill	40,000	37⅜	14,950	Landing Penitentiary, Chester, Ill.
7	St. Louis Quarry and Construction Co., St. Louis, Mo.	40,000	58	23,200	Landing St. Louis Workhouse Quarry and Chester Penitentiary Quarry.
8	John W. Reno, Chester, Ill	40,000	35	14,000	Southern Illinois Penitentiary Landing, Chester, Ill.
9	James Short, St. Charles, Mo	10,000	51	5,100	½ mile above Sand Depot, Mo.
	do	10,000	47	4,700	Chester, Ill.
	do	10,000	53	5,300	Apple Creek, Mo.
	do	10,000	60	6,000	Grays Point, Mo.
10	Martin Lorenz, St. Louis, Mo	20,000	49	9,800	Landing foot Cahokia street, St. Louis, Mo.
11	John A. Lohrum, St. Louis, Mo.	20,000	50	10,000	Landing foot Osage street, St. Louis, Mo.

Acceptance recommended of bid No. 3.

Abstract of proposals for two hydraulic dredges received in response to advertisement dated February 6, 1897, and opened March 8, 1897, at 12 o'clock, noon, by Maj. Thos. H. Handbury, Corps of Engineers, at St. Louis, Mo.

No.	Name and address of bidder.	Price for two dredges.	Price for one dredge.
1	John O'Brien Boiler Works Co., St. Louis, Mo	$224, 900. 13	$118, 000. 11
2	The Bucyrus Co., South Milwaukee, Wis	204, 800. 00	102, 400. 00

Acceptance recommended of bid No. 2.

List of contracts in force.

Articles.	Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration.
2 hydraulic dredges	The Bucyrus Co	Apr. 6, 1897	April 16, 1897	Oct. 10, 1897.
4,000 piles, more or less	H. A. Russell	Apr. 14, 1897	15 days after notice.	When delivery is completed.
20,000 cubic yards stone, more or less.	Earl E. Burke	May 5, 1897	.....do	Do.
12,000 piles, more or less	John H. Crowder	May 6, 1897	.....do	Do.

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the years 1893, 1894, 1895, and 1896.

Articles.	1893.	1894.	1895.	1896.
RECEIPTS.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barbed wire, ores, and metals (pig and manufactured)	11, 357	23, 942	24, 759	30, 395
Cement	13, 429	7, 718	11, 026	9, 342
Coal and coke	23, 180	26, 625	18, 785	50, 820
Cotton and cotton products	903	2, 249	1, 583	2, 822
Groceries and dairy products	22, 868	20, 407	16, 481	14, 449
Hay, seed, grain, flour, meal, etc	77, 709	77, 489	67, 586	55, 148
Live stock and products	13, 392	14, 820	20, 623	27, 474
Lumber	126, 510	228, 087	189, 721	173, 891
Merchandise and sundries	304, 090	175, 633	138, 317	300, 741
Vegetables and fruits	5, 440	6, 133	19, 321	6, 383
White lead, oils, etc	68	48	63	44
Wines and liquors	181	79	75	50
Wool	269	280	490	206
Total	599, 405	583, 510	508, 830	671, 765
SHIPMENTS.				
Barbed wire, ores, and metals (pig and manufactured)	7, 912	2, 066	2, 373	2, 277
Cement	....	....	....	....
Coal and coke	28, 874	76, 055	47, 402	99, 558
Cotton and cotton products	19	16	11	10
Groceries and dairy products	11, 789	9, 479	11, 645	9, 919
Hay, seed, grain, flour, meal, etc	274, 201	148, 477	123, 734	350, 180
Live stock and products	7, 631	9, 955	10, 305	10, 233
Lumber	6	3, 135	4, 452	5, 457
Merchandise and sundries	95, 099	105, 261	94, 459	85, 213
Vegetables and fruits	3, 210	1, 878	3, 273	2, 076
White lead, oils, etc	1, 513	1, 356	1, 828	2, 575
Wines and liquors	6, 038	5, 383	3, 852	4, 911
Wool	8	19	21	1
Total	436, 900	363, 080	303, 355	572, 410

Transferred by ferries across the river at St. Louis.

	Tons.		Tons.
1893	2, 829, 053	1895	2, 809, 791
1894	2, 826, 859	1896	2, 529, 786

Shipments down the river from landings between St. Louis and Cairo during the years 1893, 1894, 1895, and 1896.

Grain, including flour, meal, etc., and coal:	Tons.
1893	21,294
1894	57,120
1895	26,715
1896	75,513

RECAPITULATION.

	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	1,036,305	946,590	812,185	1,244,175
Transferred by ferries at St. Louis	2,829,053	2,826,859	2,809,791	2,529,786
Shipped from landings between St. Louis and Cairo	21,294	57,120	26,715	75,513
Total	3,886,652	3,830,569	3,648,691	3,849,474

List of steam-power boats that arrived at St. Louis during the year 1896.

Size of boats.	Draft.	Boats.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 6	86	1,251
Between 500 and 1,000 gross tons	4 to 7.6	21	711
Over 1,000 gross tons	6 to 9.5	12	382
Total		119	2,344

List of barges and scows that arrived at St. Louis during the year 1896.

Size of boats.	Draft.	Barges and scows.	Times arrived.
	Feet.		
Under 500 gross tons	2.5 to 7.5	275	976
Between 500 and 1,000 gross tons	5.2 to 8	21	95
Over 1,000 gross tons	5.3 to 9	60	236
Total		356	1,307

List of steamers and barges permanently enrolled and licensed at the port of St. Louis on the 31st day of December, 1896.

	Number of vessels.	Gross tonnage.	Net tonnage.
Permanently enrolled:			
Steamers (wood)	87	30,682.46	30,175.76
Barges	87	82,027.02	81,936.18
Steamers (iron)	4	1,690.29	1,639.82
Permanently licensed:			
Steamers under 20 tons (wood)	6	68.95	56.95
Steamers under 20 tons (iron)	3	86.50	44.90
Barges under 20 tons	2	27.79	27.79
Yachts under 20 tons	3	30.23	25.77
Total	192	114,613.24	113,907.17

CONSTRUCTION.

Cost of works during fiscal year ending June 30, 1897.

Labor, plant, and material.	Sulphur Springs, hurdles.	Rush Tower, protection.	Michaels, hurdles.	Ste. Genevieve, Ill., hurdles.	Ste. Genevieve, Mo., hurdles.	Ste. Genevieve, Mo., protection.	Chester, Mo., protection.
Labor, superintendence, etc.	$3,610.98	$784.21	$7,740.41	$875.17	$8,854.69	$435.32	$4,736.98
United States Engineer Office	619.12	160.42	758.06	150.24	1,677.40	84.20	375.06
General expense	508.00	133.73	665.55	122.76	1,382.26	69.86	281.53
Plant	1,643.48	417.26	1,834.54	400.92	4,428.56	220.36	1,102.62
Material	644.91	140.84	245.63	162.93	1,673.31	78.06	718.16
Steamer Gen. Gillmore	67.32	24.48	....	42.84	....	....	....
Steamer Gen. T. L. Casey	521.54	140.64	1,045.90	....	246.12	87.90	234.40
Steamer Gen. H. L. Abbot	....	126.63	566.03	....	310.86	....	....
Steam tenders	290.64	....	293.65	24.22	217.98	....	....
Quarter barges	....	....	101.92	16.68	105.64	....	177.92
Quarter boats	68.95	21.67	230.09	17.73	206.85	....	106.38
Office and survey boats	29.26	14.63	278.05	3.99	45.22	....	38.57
Pile drivers	452.76	....	863.98	96.04	1,042.72	....	....
Machine shop	23.30	....	....	....	....	....	....
Small boats	319.66	20.55	344.49	72.67	1,236.42	....	361.13
Portable quarters	....	....	8.13	1.65	10.45	....	17.60
Tools and appliances	122.64	30.66	405.86	51.10	511.00	....	286.16
Boarding outfit	63.24	15.81	....	26.35	263.50	....	147.56
Office furniture	4.55	.91	....	1.17	11.57	.52	6.11
Subsistence	890.18	176.59	1,186.21	147.77	2,242.72	163.23	1,362.92
Brush	750.00	....	3,449.07	229.50	3,901.19	408.20	6,861.29
Piles	2,752.59	....	6,993.09	403.68	5,120.39	....	....
Stone	878.86	1,921.69	4,109.88	407.28	6,525.56	500.11	6,335.30
Rope	27.00	....	131.25	63.00	283.32	....	220.50
Wire	235.60	....	89.41	18.72	233.52	10.45	184.30
Iron	1.78	....	1.46	....	4.90	....	2.67
Nails	....	....	34.80	....	....	....	....
Spikes	48.00	....	90.20	11.10	81.00	3.40	91.00
Screw bolts	20.49	....	....	....	5.61	....	....
Clevises	54.27	....	....	....	29.48	....	....
Lumber	19.44	....	7.29	....	8.17	....	12.15
Coal	284.65	4.59	494.22	22.98	512.84	2.30	103.87
Coal, blacksmiths'	.38	....	.38	....	.05	....	....
Material, miscellaneous	135.38	1.60	38.46	5.00	145.17	....	80.00
Total	15,097.92	4,135.91	31,997.01	3,375.49	41,319.99	2,063.91	23,844.18

Labor, plant, and material.	Liberty, protection.	Liberty, hurdles.	Power Island, Missouri, hurdles.	Portable jetties.	Dredging.	Total.
Labor, superintendence, etc.	$13,580.31	$8,920.44	$20,918.71	....	....	$70,457.17
United States Engineer Office	2,571.68	1,645.48	3,916.21	....	$766.08	12,723.95
General expense	2,126.76	1,358.30	3,226.65	....	575.04	10,450.44
Plant	7,758.68	4,334.72	9,343.85	....	2,248.26	33,733.25
Material	2,470.85	1,612.19	3,923.16	....	1,466.21	13,136.25
Steamer Gen. Gillmore	250.92	....	....	....	12.24	397.80
Steamer Gen. T. L. Casey	375.04	105.48	568.42	....	462.48	3,787.92
Steamer Gen. H. L. Abbot	....	325.16	273.43	....	6,115.73	7,705.36
Dredge No. 1	....	....	....	....	7,956.95	7,956.95
Dredge No. 2	....	....	....	....	2,126.94	2,126.94
Steam tenders	145.32	726.15	....	....	....	1,697.96
Quarter barges	....	....	266.88	....	....	669.04
Quarter boats	226.55	185.18	....	....	....	1,063.40
Office and survey boats	139.65	31.92	129.01	....	....	710.30
Pile drivers	41.16	823.20	3,299.66	....	....	6,619.52
Machine shop	27.96	70.20	....	....	....	121.46
Small boats	928.14	872.73	1,797.47	....	....	5,953.26
Portable quarters	....	....	26.40	....	....	64.23
Portable jetties	....	....	....	$28,850.31	....	28,850.31
Tools and appliances	735.84	367.92	1,032.22	....	....	3,543.40
Boarding outfit	379.44	189.72	532.27	....	....	1,617.89
Office furniture	16.77	11.05	27.17	....	12.48	92.30
Subsistence	3,563.99	2,082.38	5,182.10	....	....	17,007.09
Brush	12,597.46	5,929.50	9,329.22	....	....	43,455.43
Piles	156.60	5,989.34	14,363.82	....	....	35,779.51
Stone	18,281.14	4,829.63	14,277.76	....	....	58,067.21
Rope	270.00	457.29	558.00	....	....	2,010.36
Wire	368.10	234.39	522.60	....	....	2,089.09
Iron	....	1.78	6.78	....	....	19.37
Nails	28.51	....	1.70	....	....	65.01
Spikes	131.00	65.00	227.04	....	....	747.74
Screw bolts	....	34.54	79.20	....	....	139.93
Clevises	....	186.93	238.52	....	....	509.20

Cost of works during fiscal year ended June 30, 1897—Continued.

Labor, plant, and material.	Liberty, protection.	Liberty, hurdles.	Power Island Missouri, hurdles.	Portable jetties.	Dredging.	Total.
Lumber	....	$9.72	$29.16	....	....	$85.93
Oakum	....	1.54	....	....	....	1.54
Coal	$134.36	329.76	1,150.23	....	....	3,039.80
Coal, blacksmiths'	....	.38	1.09	....	....	2.28
Material, miscellaneous	39.64	132.11	384.30	....	....	961.66
Total	67,515.87	41,854.13	95,633.12	$28,850.31	$21,742.41	$377,460.25

Total cost of works to June 30, 1897.

Name of work.	Expended— Prior to July 1, 1896.	During year 1896–97.	Total.
Sawyer Bend, protection	$96,803.63	....	$96,803.63
Venice dikes	36,341.85	....	36,341.85
St. Louis Harbor	144,048.94	....	144,048.94
Arsenal Island, protection	42,599.06	....	42,599.06
Closing Cahokia Chute	119,958.21	....	119,958.21
Channel opposite St. Louis	58,455.54	....	58,455.54
Horsetail Bar, dikes 1 to 5, inclusive	225,066.31	....	225,066.31
Horsetail Bar, training wall	81,253.28	....	81,253.28
Horsetail Bar, hurdles	618,447.68	....	618,447.68
Horsetail Bar, bank protection	68,632.42	....	68,632.42
Carrolls Island, hurdles	40,343.98	....	40,343.98
Twin Hollows, west side, hurdles	315,611.64	....	315,611.64
Twin Hollows, west side, bank protection	56,567.66	....	56,567.66
Twin Hollows, east side, bank protection	129,435.57	....	129,435.57
Pulltight, hurdles	519,185.10	....	519,185.10
Pulltight, bank protection	1,818.23	....	1,818.23
Beards Island, primary hurdle	7,166.24	....	7,166.24
Beards Island, bank protection	84,258.76	....	84,258.76
Chesley Island, hurdles	27,808.61	....	27,808.61
Chesley Island, bank protection	73,916.55	....	73,916.55
Jim Smiths, hurdles	365,803.33	....	365,803.33
Jim Smiths, bank protection	7,569.58	....	7,509.58
Sulphur Springs, hurdles	356,252.39	$15,097.92	371,350.31
Foster Island, protection	46,637.49	....	46,637.49
Lucas, hurdles	272,802.82	....	272,802.82
Cornice Island, hurdles	63,545.27	....	63,545.27
Rush Tower, hurdles	218,267.90	....	218,267.90
Michaels, hurdles	129,169.19	31,997.01	161,166.20
Rush Tower, bank protection	82,312.83	4,135.91	86,448.74
Danbys, bank protection	25,190.80	....	25,190.80
Fort Chartres, dam	36,812.86	....	36,812.86
Fort Chartres, west side, hurdles	225,883.99	....	225,883.99
Fort Chartres, west side, bank protection	19,458.12	....	19,458.12
Bruce Island, bank protection	3,971.99	....	3,971.99
Fort Chartres, east side, bank protection	39,846.88	....	39,846.88
Crooks	39,829.94	....	39,829.94
Turkey Island, dam	24,463.85	....	24,463.85
Turkey Island, bank protection	28,829.33	....	28,829.33
Ste. Genevieve, Ill., hurdles	267,246.44	3,375.49	270,621.93
Ste. Genevieve, Ill., bank protection	26,189.35	....	26,189.35
Ste. Genevieve, Mo., hurdles	215,735.96	41,319.99	257,055.95
Ste. Genevieve, Mo., bank protection	....	2,063.91	2,063.91
Moro Island, bank protection	1,045.26	....	1,045.26
Kaskaskia, bank protection	66,465.62	....	66,465.62
Chester, Mo., bank protection	....	23,844.18	23,844.18
Liberty Island, dam	5,053.91	....	5,053.91
Liberty Island, bank protection	83,699.54	67,545.87	151,245.41
Liberty Island, hurdles	140,510.75	41,854.13	182,364.88
Devils Island, dike No. 1	65,871.17	....	65,871.17
Devils Island, dams 1 and 2	66,526.88	....	66,526.88
Minton Point, hurdles	33,436.37	....	33,436.37
Cape Girardeau, primary hurdles	31,930.18	....	31,930.18
Power Island, Mo., hurdles	....	95,633.12	95,633.12
Cairo, bank protection	160,430.82	....	160,439.82
Portable jetties, operating	15,352.38	28,850.31	44,202.69
Dredging	2,810.61	21,742.41	24,553.02
Total	5,916,682.06	377,460.25	6,294,142.31

Total cost of work to June 30, 1897—Continued.

PROPERTY ACCOUNT.

Class of property.	Value July 1, 1896.	Debits.	Credits.	Value June 30, 1897.
Steamer Gen. Gillmore	$15,369.92	$16,178.39	$14,251.48	$17,296.83
Steamer Gen. T. L. Casey	22,909.59	17,790.92	17,946.20	22,754.31
Steamer Gen. H. L. Abbot	39,166.22	19,212.59	19,700.00	38,678.81
Dredge No. 1	1,516.07	27,297.60	7,956.95	20,856.72
Dredge No. 2	....	28,093.13	2,126.94	25,966.19
Dredge No. 3 Dredge No. 4	....	1,202.98	....	1,202.98
Steam tenders	26,207.66	3,467.59	3,950.42	25,724.83
Barges, model	151,232.40	22,465.35	20,802.59	152,895.16
Barges, quarter	12,666.55	371.18	2,171.18	10,866.55
Quarter boats	47,026.45	5,858.97	2,029.31	50,856.11
Office and survey boats	14,259.53	651.72	981.97	13,929.28
Pile drivers	126,867.51	7,582.97	11,303.75	123,146.73
Derrick boats	8,473.65	976.98	529.06	8,921.57
Derricks	1,824.35	....	263.39	1,560.96
Machine shop	1,043.26	1,418.78	482.61	1,979.43
Small boats	31,743.39	8,259.57	7,596.99	32,405.97
Portable quarters	4,169.60	370.04	570.33	3,969.31
Portable jetties	3,848.99	51,362.78	28,850.31	26,361.46
Ways (supply depot)	2,352.11	638.02	475.72	2,514.41
Supply depot	4,095.19	6,001.76	1,667.88	8,429.07
Tools and appliances	16,476.14	11,226.65	6,478.92	21,223.87
Boarding outfit	27,751.26	1,621.36	3,123.39	26,249.23
Office furniture	572.12	18.50	114.42	476.20
Survey instruments	1,900.58	133.82	190.05	1,844.35
Photographic apparatus	257.14	....	....	257.14
Total	556,729.68	232,201.65	153,563.86	635,367.47

MATERIAL ACCOUNT.

Class of material.	Value July 1, 1896.	Debits.	Credits.	Value on hand June 30, 1897.
Subsistence	$2,029.05	$34,353.86	$33,273.24	$3,109.67
Brush	3,534.11	41,894.50	43,455.43	1,973.18
Piles	998.63	44,425.87	37,810.67	7,613.83
Stone	2,688.89	56,681.71	58,177.61	1,192.99
Rope	27,573.85	3,878.83	3,109.98	28,342.70
Wire	2,491.79	1,465.48	2,251.73	1,705.54
Iron	3,540.32	18,594.22	19,559.44	2,575.10
Nails	1,474.25	93.03	271.44	1,295.84
Spikes	1,719.33	1,141.10	1,024.40	1,836.03
Bolts, screw	972.11	....	230.28	741.83
Bolts, assorted	46.86	....	17.17	29.69
Clevises	446.66	258.56	509.20	196.02
Lumber	5,588.35	12,474.81	10,334.24	7,728.42
Lumber (linear feet)	1.74	....	....	1.74
Oakum	467.68	573.00	895.70	144.98
Coal	2,126.75	22,178.15	23,223.48	1,081.42
Coal, blacksmiths'	35.18	153.58	185.41	3.35
Ice	....	3,834.07	3,834.07	....
Material, miscellaneous	11,083.70	39,959.13	44,456.27	6,586.56
Total	66,819.25	281,959.40	282,619.76	66,158.89

REPORT OF MR. D. M. CURRIE, ASSISTANT ENGINEER.

St. Louis, Mo., *June 30, 1897.*

Major: I have the honor to submit the following report upon the improvement of the Mississippi River between the Ohio and Missouri rivers for the fiscal year ending June 30, 1897.

The operations for the year comprised the construction of works for the improvement of the river at Sulphur Springs, Michaels, Rush Tower, Ste. Genevieve, Chester, Liberty, and Powers Island, and for temporary relief to navigation; portable jetties at Turkey Island, Ste. Genevieve, Seventy-six Landing, Schenimans, Goose Island, and Hackers Bend, and, with the exception of Seventy-six Landing, all supplemented by dredging. Dredging was also done at Chain of Rocks, Harrisonville, Calico Island, and foot of Grand Tower Bend.

At Sulphur Springs, east side, repairs, extensions, and additions were made to hurdles as far as practicable at the stages of water prevailing during the fall season, equivalent in the aggregate to 990 feet of new hurdle, distributed as follows: On 1½, 600 feet; on 3½, 220 feet; and on 5½, 170 feet, in which 837 piles were driven, 89 braces placed, 540 linear or 54,000 square feet of foundation mattress fabricated and sunk, 115 linear or 11,500 square feet of mattress fabricated and placed to protect shore ends, 555 linear or 6,710 square feet of foundation mattress, and 2,775 square feet of drift mattress fabricated and sunk, 2,300 linear or 33,815 square feet of curtains fabricated and placed, and 500 linear or 13,500 square feet of revetment placed. In the protection of the head of Stantons Towhead 295 linear or 24,970 square feet of mattress was fabricated and sunk.

The bank opposite Chester, Ill., was protected by a mattress placed below water surface and revetment above to the stage of 10 feet above low water of 1863, St. Louis gauge, to a distance of 3,310 feet below the railway incline at Clearyville, Mo., in which the quantities of work are 3,310 linear or 413,750 square feet of mattress fabricated and sunk and 3,310 linear or 75,560 square feet of revetment placed.

At Liberty hurdles Nos. 1, 4, 7, and 10 were extended to completion, and No. 11 was begun and extended 1,140 feet from shore as far as practicable at the low stages which prevailed during the first half of the year when the work was done. The east bank was protected to a distance of 6,850 feet from its initial point near the head of Liberty Bend by a subaqueous mattress about 130 feet average width, but varying between 128 and 144 feet, and by revetment 41 feet in average width, extending to the plane of 20-foot stage on the upper 4,450 feet, then gradually down to 14-foot stage on the next 800 feet, which continued to the end. The quantities of work are: In hurdles, 1,429 piles driven; 285 braces placed; 1,455 linear or 162,900 square feet of foundation mattress fabricated and sunk; 720 linear or 43,200 square feet of drift mattress fabricated and sunk; 36,630 square feet of revetment placed, and 2,317 linear or 43,072 square feet of curtains fabricated and placed. In protecting Liberty Bend the quantities of work are, 6,850 linear or 886,400 square feet of mattress fabricated and sunk; 6,850 linear or 280,463 square feet of revetment placed; 12,418 cubic yards of earth excavated, and 34 piles driven.

At Powers Island a hurdle dam 1,600 feet long was built across Doolan Slough, about 2½ miles below Beaver Dam Rock, the point at which the volume passing through the slough at low water separated from the main branch of the river. The distance from the dam to the junction of the slough with the main branch at the foot of Powers Island is about the same as that above the dam to the point of separation, making the possible head at the dam about 3½ feet, due to the fall in 5 miles at the rate of 0.7 of a foot per mile, as determined by recent survey. The location was the most favorable for stability in the slough, but on account of the possible pressures, unstable bed, and banks extra precautions were taken to secure permanency of the dam. The number of piles was increased to more than double that ordinarily used in hurdles, the foundation mattress was doubled over the space between upper and lower rows of piles, the bottom was brought to uniform level by making layers of drift and brush cribs, and the tops of the piles extended to a height which would prevent drift passing over them while the river remained within its banks. Drift was sunk above the dam on half of its length from the island and cribbed mattresses above the other half. Clumps of piles were driven through these mattresses in the deep water to a distance of 600 feet from the Missouri shore. The bank at each end was protected to a distance of 250 feet above and 350 feet below the dam by a subaqueous mattress and stone revetment above to the top of the bank, which was graded to a slope of 2 to 1 to receive it. A spur dike extending from the top of the dam at a point 100 feet from the end of the piling was built at each end to make shore connections.

During the high water of January the revetment at each end settled about 5 feet and was repaired with stone removed from the top of the bank.

The quantities of work are as follows: Piles driven, 3,525; braces placed, 413; foundation mattress fabricated and sunk, 2,510 linear or 371,175 square feet; drift mattress fabricated and sunk, 4,421 linear or 117,525 square feet; curtains fabricated and placed, 450 linear or 7,180 square feet; revetment placed for protection of ends of dam, 1,160 linear or 49,850 square feet, and 4,870 cubic yards of earth excavated in grading 1,383 linear feet of bank.

The quantities of work done in hurdles and bank protection are shown in the accompanying tables.

Table of work done on hurdles during the fiscal year ending June 30, 1897.

Locality.	Foundation mattress fabricated and sunk.		Drift mattress fabricated and sunk.		Shore mattress fabricated and ballasted.		Curtain constructed.	
	Lin. ft.	*Sq. ft.*	*Lin. ft.*	*Sq. ft.*	*Lin. ft.*	*Sq. ft.*	*Lin. ft.*	*Sq. ft.*
Sulphur Springs:								
Hurdle No. 1½	540	54,000			115	11,500	380	3,560
Hurdle No. 2½								
Hurdle No. 3½							175	3,150
Hurdle No. 5½								
Total	540	54,000			115	11,500	555	6,710
Michaels Landing:								
Hurdle No. 1								
Hurdle No. 2	2,416	306,863						
Total	2,416	306,863						
Ste. Genevieve, Ill.:								
Hurdle No. 15							230	2,625
Ste. Genevieve, Mo.:								
Hurdle No. 8								
Hurdle No. 12			650	19,200			270	4,590
Hurdle No. 14	705	81,600	1,265	47,050				
Hurdle No. 15			860	24,250			1,800	28,600
Total	705	81,600	2,775	90,500			2,070	33,100
Liberty:								
Hurdle No. 1			720	43,200				
Hurdle No. 4							545	12,360
Hurdle No. 7							747	13,297
Hurdle No. 10	300	33,600					665	13,235
Hurdle No. 11	1,155	129,360					360	4,280
Total	1,455	162,960	720	43,200			2,317	43,172
Powers Island, Mo.:								
Hurdle dam	2,510	371,175	4,421	117,525			1,450	7,180
Grand total	7,626	976,598	7,916	251,225	115	11,500	6,622	92,877

Locality.	Revetment placed.		Earth excavated.	Buttresses built.	Piles driven.	Penetration of piles.	Braces placed.
	Lin. ft.	*Sq. ft.*	*Cub. yds.*	*No.*	*No.*	*Feet.*	*No.*
Sulphur Springs:							
Hurdle No. 1½		3,085			564	10,267	81
Hurdle No. 2½					8	147	
Hurdle No. 3½		3,000			191	3,414	8
Hurdle No. 5½					74	1,274	
Total		6,085			837	15,102	89
Michaels Landing:							
Hurdle No. 1	506	26,020			195	3,383	3
Hurdle No. 2					1,670	33,428	
Total	506	26,020			1,865	36,811	3
Ste. Genevieve, Ill.:							
Hurdle No. 15					151	2,398	
Ste. Genevieve, Mo.:							
Hurdle No. 8	175	5,250					
Hurdle No. 12	275	8,250		1			
Hurdle No. 14				1	1,028	17,458	45
Hurdle No. 15				1	419	7,045	
Total	450	13,500		3	1,447	24,503	45
Liberty:							
Hurdle No. 1							
Hurdle No. 4							
Hurdle No. 7							2
Hurdle No. 10		21,250			709	11,941	162
Hurdle No. 11		15,380	800		720	12,980	121
Total		36,630	800		1,429	24,921	285
Powers Island, Mo.:							
Hurdle dam	1,160	49,850	4,870		3,525	65,353	413
Grand total	2,116	132,085	5,670	3	9,254	169,088	835

Table of work done on bank protection during the fiscal year ending June 30, 1897.

Locality.	Bank protection mattress fabricated and sunk.		Revetment placed.		Earth excavated.	Piles driven.	Penetration.
	Lin. ft.	*Sq. ft.*	*Lin. ft.*	*Sq. ft.*	*Cub. yds.*	*No.*	*Feet.*
Rush Tower				54, 900			
Ste. Genevieve, Mo	295	24, 970	250	7, 500			
Chester, Ill	3, 310	413, 750	3, 310	75, 560			
Liberty, Ill	6, 850	886, 400	6, 850	280, 483	12, 418	34	566
Total	10, 455	1, 325, 120	10, 410	418, 443	12, 418	34	566

PROCURING MATERIALS.

Of the brush required, 26,899 cords was procured by hired labor.

Of the stone required, 28,188.8 cubic yards was procured by hired labor; 11,808.7 cubic yards from Martin Lorenz, and 11,887.8 cubic yards from Bussen Bros. by contract, and 8,508.8 cubic yards was purchased in open market. Of the piles required, 11,729 were procured by contract and 268 by purchase in open market.

TEMPORARY EXPEDIENTS.

Upon the approach of the low-water season, about the 1st of September, shoal bars appeared at the Chain of Rocks above and at several points below St. Louis, threatening to seriously obstruct navigation. This was prevented by the use of portable jetties and dredging, both separately and combined.

The plant available at the beginning of the season comprised the stern-wheel steamer *Gen. H. L. Abbot* with jet pumps arranged to discharge in front of the wheel, the boat being held in position by spuds while the wheel moved ahead slowly, half or full head as required; dredge No. 1, described in report of Chief of Engineers for 1896, and a stock of panels for the construction of portable jetties.

During the season further additions were made to the plant by completion of dredge No. 2, placing spuds on the steamer *Gen. T. L. Casey*, and by the construction of additional panels for jetties to a number sufficient for 10,000 feet.

The work was inaugurated September 4 to 12, on the former date by dredge No. 1, at Harrisonville, where the river had divided into three distinct channels, each with a minimum depth of 4½ feet; on the latter date by the *Abbot*, at the Chain of Rocks, where 4 feet was the depth, and by a portable jetty at Turkey Island, where the depth was 5 feet.

The work was continued to the close of the season, about the 1st of December, by dredging and placing portable jetties as required to maintain a minimum channel depth of 6 feet.

Dredge No. 1, upon leaving Harrisonville, worked successively at Ste. Genevieve, foot Grand Tower Bend, Schenimans, then returned to Harrisonville and thence to Calico Island, where it closed the season's operations. The *Abbot* patrolled the river to Cairo, found and buoyed the best channel bars, dredging where necessary to secure 6-foot depth; moved plant engaged in this work, in addition to towing in connection with both temporary and permanent works.

The aggregate length of portable jetties was 6,560 feet, in seven lines, varying between 1,350 and 460 feet, placed and removed as follows: Turkey Island, 1,150 feet, placed September 12–15, removed November 16–20; Ste. Genevieve, east side, 1,000 feet, placed October 23–30, removed December 2–5, and 460 feet, west side, placed November 4–9 and removed November 28–December 3; Seventy-Six Landing, 750 feet, placed October 14–20 and removed November 27–30; Schenimans, 1,000 feet, placed October 4–20 and removed November 27–30; Goose Island, 850 feet, placed October 17–22 and November 9–11 and removed November 23–25; and at Hackers Bend, 1,350 feet, placed October 26–November 6 and removed November 17–21.

The depth increased at all the localities between dates of placing and removing the jetties from 3½ feet at Turkey Island to 1½ feet at Seventy-Six Landing, from one-fourth to 1 foot of which, however, may have been due to the higher stages of water when removed, except at Seventy-Six, where the stage was half a foot less at the time of removal than at the time of placing the jetty. The channel depths at the dates of placing and removal, respectively, were: At Turkey Island, 6½ and 10 feet; at Ste. Genevieve, 5½ and 7½ feet; at Seventy-Six Landing, 8 and 9½ feet; at Schenimans, 5 and 8 feet; at Goose Island, 6 and 8 feet, and at Hackers Bend, 6½ and 8½ feet. This shows an increase, on account of temporary expedients, of about 2 feet in depth upon the average.

Dredging alone also gave satisfactory results. At the Chain of Rocks the *Abbot*, in nine working hours, dredged a new channel with 5-foot depth, crossing the bar with easy curves instead of the tortuous one, with less than 4 feet depth found there.

At Harrisonville there were three channels, each with depths varying between 4½ and 5½ feet. The lower of these was selected to be dredged because it was improving, while the others were deteriorating. Dredge No. 1 worked there from September 4–11 and increased the minimum depth from 4½ feet to 7½ feet.

On October 5 the *Abbot* removed a lump from this channel, and November 2–14 dredge No. 1 cut off a point of the upper reef that projected into the channel.

At Calico Island two low-water channels developed, each with 4 feet depth, one passing by Cornice Island hurdles, the other by Calico Island. The latter was 180 feet wide and reasonably straight, while the other was narrow and tortuous, and therefore was selected to be dredged. The depth was increased to 7½ feet and the width to 300 feet by dredge No. 1, working from October 18–31.

At Turkey Island the *Abbot* worked eight hours October 7 in the channel undergoing process of improvement by the portable jetties then in position, with the result of an increase of 2½ feet to a least depth of 10 feet with ample width.

The Ste. Genevieve reach had been greatly improved by the hurdles under process of construction, but a shoal developed near the lower end of the series, where the hurdles were either incomplete or had not been built long enough to have secured their full effect upon the channel. This shoal consisted of a hard ridge of gravel over blue clay, and could be crossed by either of three channels with nearly the same depth, known as the lower, middle, and upper ways. The last named had the least depth, but on account of its easy curves was the best for permanency and for use by descending steamers; therefore an effort was made to improve it by dredging. Dredge No. 1 began work on the morning of September 15, and the *Abbot* began during the forenoon of the same day, and both worked continuously until noon of the following day, when the *Abbot* was withdrawn for other work. The dredge continued the work night and day until the 18th without securing material improvement, as the sand moved into it from above about as fast as it was removed. The excavated material was carried by the currents across the lower reef, however, of this channel to the upper end of the lower channel and caused an increase in depth of that channel. The dredge was changed from the upper to the lower channel on the 18th, and by the 20th had increased its depth to 8 feet.

The shoal re-formed and was dredged October 4, 7, and 28–29 by the *Abbot*, and the channel was afterwards kept open by the portable jetties placed October 23–30 and November 4–9.

Work was begun by dredge No. 1 on a shoal at the foot of Grand Tower Bend September 21, and continued to October 1 with interruptions on account of a rise in the river. A channel depth of 8 feet was secured. This channel shoaled to 6 feet, and was again dredged by the *Abbot* October 9, after which it remained open.

One of the most persistent shoals encountered during the entire season was that at Schenimans. This consisted of a reef of coarse sand which moved out readily under the action of dredge No. 1 and the *Abbot* separately and combined, but sand of the same character moved down from the bar above and rapidly re-formed the shoal, so that the improvement of dredging was indeed temporary. Dredge No. 1 worked alone from October 2–10, and in connection with the *Abbot* from the latter date to the 15th, when dredging was suspended and a portable jetty was placed. After this, twelve hours' dredging by the *Abbot* November 2–3 secured the desired channel depth, which continued until the jetty was removed at the end of November. The channel shoaled again and was dredged out by the steamer *Casey* December 12–14.

Goose Island has long been noted as one of the worst shoals between St. Louis and the Ohio River. It presented only a single short shoal this year, across which the *Abbot* dredged a channel October 3, and a jetty 500 feet long placed there October 17–21 and extended to 650 feet in length November 9–11 maintained ample depth and width of channel throughout the season.

Hackers Bend shoaled late in the season, and after placing a temporary jetty there the *Abbot* worked nine hours October 31, and secured the desired depth and width of channel.

This completes the account of actual field work prosecuted during the year for the improvement of this section of the river for temporary relief to navigation.

FORMS OF CONSTRUCTION.

Forms of construction for hurdles and bank protection remain of the same type as has been in use several years, with such changes in detail at each locality as may be required to suit existing conditions. In portable jetties some of the changes were important. The panels rested on stringers attached to the upstream side of piles instead of, as heretofore, on flats supported by the piles. The weight of steel and depth of new panels were increased. The panels of 1895 were 10 by 10 feet corrugated steel, No. 16, riveted to 3 angle bars 16 feet long. The new panels were made of the same width, 10 by 14 feet and 18 feet deep, of No. 14 corrugated steel, riveted to 3 steel I-bars 12.25 and 14.75 pounds per foot. These changes increased the weight from 650 pounds to 1,100 pounds and 1,600 pounds per panel for depths 14 and 18 feet, respectively. A mattress built of fascines was attached to the lower edge of each panel before it was sunk in all of the portable jetties except at Turkey Island and at Seventy-Six Landing, where the panels were placed without protection against scour. These were built during the early part of the season and the scour was such as to weaken the jetties and show that protection was necessary.

The cost of the portable jetties was $4.40 per linear foot, including towage, service of plant, supervision, and all contingent expenses. If the jetties had not been removed their cost would have been $6.06 per linear foot.

PLANT.

The plant was constructed, repaired, and outfitted as required.

Dredges Nos. 1 and 2 and 800 panels for portable jetties comprise the principal items of construction.

Barges Nos. 102, 103, 105, 108, and 113 were pulled out at the engineer depot and thoroughly repaired.

The steamers *Gen. H. L. Abbot*, *Gen. T. L. Casey*, and *Gen. Gillmore*, steam tenders, barges, quarter boats, pile drivers, derrick boats, small boats, engineer depot, and portable buildings were repaired as required.

RESULTS.

All shoals have been either removed or greatly improved from St. Louis to the foot of Liberty, a distance of about 90 miles, as far as the works have been carried downstream on a project which embraces continuous improvement, and at detached points at which work has been prosecuted in advance of the general project.

SURVEYS, GAUGES AND STAGES OF RIVER.

The survey from Red Rock, Missouri, was prosecuted and was completed with triangulation from the Ohio River to the Grand Chain, thence sketched to Cape Rock, plane table survey from Cape Rock to Moccasin Springs, partly finished survey from Red Rock to Grand Tower, and borings in the west chute at Grand Tower.

Additional gauges were established at Red Rock, Commerce, Thompsons, and Grand Tower.

The stages of water were neither extremely high nor very low. On St. Louis gauge the highest 30.9 feet, and the lowest 3.8 feet.

ACCOMPANYING REPORTS.

I am indebted to the reports of assistants in local charge for much of the information contained in this report, especially statements of quantities of work and other details as follows: Upon works at Sulphur Springs, Rush Tower, and Liberty, to the report of Mr. Gerald Bagnall, assistant engineer; upon works at Ste. Genevieve, Chester, Powers Island, and portable jetties to the report of Mr. William S. Mitchell, assistant engineer; upon procuring brush and stone by hired labor, to the report of Mr. E. D. Libby, assistant engineer; upon surveys and gauges, to the report of Mr. John O. Holman, assistant engineer; and upon construction and repairs of plant by hired labor, and other operations at the engineer depot, to the report of Mr. C. D. Lamb, superintendent.

PLATES.

For further information, this report refers to plates numbered I, II, III, IV, and V, showing location and extent of works for the improvement; No. VI showing portable jetty or dike used in improving low-water navigation, and No. XII showing surveys from Red Rock, Missouri, to the Ohio River.

Very respectfully, your obedient servant,

D. M. CURRIE, *Assistant Engineer*.

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. MITCHELL, ASSISTANT ENGINEER, ON WORKS AT MICHAEL, STE. GENEVIEVE REACH, CHESTER, ILL., POWER ISLAND, AND ON PORTABLE JETTIES.

ST. LOUIS, MO., *June 30, 1897*.

MAJOR: I have the honor to submit the following report of operations for the permanent improvement of the Mississippi River near Ste. Genevieve, Chester, and Commerce and for the temporary correction of the low-water channel by means of portable jetties for the fiscal year ending June 30, 1897.

For the amounts of work done and expenditures in materials and labor reference is made to the accompanying tables.

The locations of the various works are shown on the charts on file, and their description will be given in their order downstream.

ICHAEL LANDING.

Hurdle No. 1.—In May, 1896, this hurdle was broken through by two coal barges which had been set adrift at St. Louis by the tornado of that month, and although the break was small, yet, owing to unfavorable stages of river during the remainder of the year, it could not be reached for repairs. The high water of the winter and the flood of the spring poured through the gap, widening and deepening it greatly. On the resumption of work in June on account of the depths found it was decided not to attempt to restore the piling in the gap at present, but to strengthen the remainder of the line and to build hurdle No. 2 in the deposit which had been gained below No. 1. The piling was strengthened by additional timber, by recabling, by resetting and bolting braces, and the revetment at the outer end of the line on Osborne Towhead was repaired and raised to the top of the bank.

Hurdle No. 2.—This line was begun June 11 and at the close of the year was nearly completed. It is 2,800 feet in length and will be finished in July. It is of the ordinary type, with a foundation mattress widened to 125 feet on account of the soft deposit in which it is built. The piling is in two rows of three pile clumps spaced 6 feet apart, a third row being added in the deeper water through which the line passes.

STE. GENEVIEVE, ILL.

Hurdle No. 15.—The extension of this line to the Illinois bank was in progress at the beginning of the fiscal year and was completed July 9.

STE. GENEVIEVE, MO.

Hurdles Nos. 6, 8, and 10.—In July slight additions were made to the stone revetments of Nos. 6 and 10, raising that of the former to the 16-foot contour and that of the latter to the 20-foot contour. The entire stone revetment at the shore end of No. 8 was laid.

Hurdle No. 12.—This line was almost finished at the beginning of the year. It was completed July 22, the work done consisting of sinking drift along the outer end of the piling, finishing the curtaining and placing the shore revetment. An ice buttress was built at the junction of the line with the channel limit, and the piling was extended 100 feet beyond that point across the T-head mattress.

Hurdle No. 14.—Work on this hurdle was continued until August 26, when it was completed, with the exception of curtains, which could not be placed because of the accumulation of drift above the entire length of the piling. A portion of this drift was sunk along the outer half of the line. In the deepest water a second sinking was made and the piling there was also braced from the lower side. An ice buttress similar to that on No. 12, and similarly placed, was built, and the piling was also extended across the T-head mattress as in the former line.

Hurdle No. 15.—This hurdle was also in process of construction at the beginning of the year, and at the end of August was completed. It was curtained for its full length, the drift along its outer portion was sunk, and a buttress was built at its river end.

Stanton towhead.—A protection mattress was begun in the latter part of July at the upper end of the towhead, but only 300 linear feet were fabricated and sunk when the part was moved to Power Island for work of greater urgency.

CHESTER, ILL.

Bank protection.—The protection of the Missouri bank opposite Chester was begun September 8, and work was completed for the season October 27. The mattress was of the ordinary type, 125 feet wide, and extends downstream 3,310 feet from the end of the old railroad incline, past the water front of the town of Clearyville to the fields below. Above the mattress no grading was attempted, the stone revetment being carried on the natural slope of the bank to the following heights:

For 900 feet below the incline to the 9-foot contour.
For 1,300 feet below the incline to the 13-foot contour.
For 1,100 feet below the incline to the 8-foot contour.

The mean elevation is about 10 feet, all referred to the St. Louis gauge.

About 2,500 cubic yards of stone will be required to complete the revetment to the 20-foot contour. This will be done during the coming season, as the spring high water has graded the upper part of the bank to the desired slope. The completion of this work will exhaust the appropriation under which it was begun.

POWER ISLAND.

A permeable dam to close Doolan Slough, the chute between Power Island and the Missouri shore below Commerce, was built, July 9 to September 9, with the force from Ste. Genevieve, which was transferred to the dam as rapidly as it was released from the former work.

For many years, at low-water stages, this chute has diverted a very considerable portion of the river volume which otherwise would have gone to the improvement of the shoals at "Jacket Pattern" and "Goose Island," both of which have been serious obstacles to navigation.

The dam was located nearly 2 miles below the head of Power Island and 4 miles below Commerce, Mo., across a narrow part of the chute, which was there about 1,600 feet in width, and where the banks were firm and the cross section regular. At a stage of 13 feet, St. Louis gauge, the mean depth was 20 feet and the maximum depth 27 feet near the Missouri shore. The type of construction was that of the ordinary pile hurdle, with the material for three hurdles massed in one.

The piling was driven in three rows, 4 feet apart, of clumps, spaced 6 feet centers of 3 and 4 sticks each, according to depth of water. The clumps in each row were staggered with those in the adjacent rows. The rear row was braced in the usual manner, and although no stringers were bolted on, yet between the adjacent rows short cotton wood stringers were laid so that strain in the upper row would be quickly distributed through all. The tops of the piles were left at the level of the tops of the adjacent banks, an elevation corresponding to a 30-foot stage. After the first two rows of clumps were driven the piling was so crowded that it was found necessary to discontinue the use of the water-jet as it loosened piles already driven and induced scour. The remaining piles were driven with the hammer alone. The average penetration for all piles was 18½ feet.

The foundation for the dam was an ordinary continuous woven mattress widened to 150 feet, two-thirds of the width lying below the piling. On top of this mattress another 50 feet wide, and in the deep water third and fourth tier mattresses 25 feet wide, were laid just below the main rows of piling to reenforce them to build up the bottom to an even cross section and to receive the overfall from the dam. The brace pile clumps were driven through these auxiliary mats.

Unfortunately the brush obtained was very large, necessitating the use of unusual quantities both of it and of stone wherewith to sink it. As such still brush does not quickly conform to irregularities of bottom nor follow down in case of scour until the latter has assumed dangerous proportions, a very large excess of stone was used as ballast.

During construction a large body of drift accumulated above half the length of the hurdle next the island. This was sunk, and along the other half of the line, to bring all to a common crest, cribbed brush mattresses were built and sunk. A fourth row (600 feet long) of four-pile clumps were driven through these cribbed mattresses in the deep water next the Missouri shore, and the entire front of the dam was curtained to the level of a 10-foot stage.

The bank at each end of the dam was protected by a mattress 600 feet long by 125 feet and 150 feet wide on the east and west sides, respectively, and extending 250 feet above and 350 feet below the structure. From their tops to the edges of these mattresses the banks were graded by water jets to a slope 2:1, and on this slope a stone revetment was laid in two courses, the first, 9 inches thick, of spalls extending from the lower ends of the mats to 50 feet above the piling, and over this dressing a heavy course of stone was laid, covering the entire graded bank.

A small spur dike of stone was built on each bank, with crest sloping from the top of the revetment to the piling at the 20-foot level, and on that slope 100 feet into the line forming shore connections for the dam.

The greatest head of water observed on the dam during construction was 22 inches, September 8 (St. Louis gauge, 6.4 feet).

At the close of the season water still poured through the structure, although its beneficial effect was manifest during the low-water season in increased navigable depths over the neighboring shoals at Jacket Pattern and Goose Island.

On September 30 a slight settling was reported in the west spur dike and revetment back of the mattress. They were restored and strengthened by the addition of three bargeloads of stone in the early part of October.

During the winter the river rose to an extraordinary height for that season, 24.8 feet (January 7), and after its subsidence both revetments sank about 5 feet just above the spur dikes, the west revetment January 15 and the east revetment January 29. Both were repaired, January 18 and 19 and February 4–6, respectively, with a force hired at Commerce and with stone taken from the tops of the revetments, narrowing them about 8 feet.

In April the spring rise reached 28½ feet and overflowed Power Island and the Missouri bank, flowing around the ends of the dam in streams about 200 feet in width and with considerable velocity, but no serious damage was done.

Large fields of drift were caught above the piling, which will be sunk at the first opportunity.

PORTABLE JETTIES.

In the early part of September the river reached a 6-foot stage, St. Louis gauge, and a number of bars threatened to become serious obstructions to navigation.

To correct the channel temporarily at Turkey Island, Stanton's, Seventy-six Landing, Schenimans, Goose Island, and Hacker Island, jetties were built similar to that used at Danby Landing in 1895. Only one jetty was required at each of these places, with the exception of Stanton's, where there were two, one on either side of the channel.

Work was begun at Turkey Island September 12, and, although interrupted by a sharp rise of 5 feet September 15 to 29, was completed at Goose Island November 11. The aggregate length of the jetties was 6,560 feet for seven lines, varying from 1,350 feet to 460 feet, and they remained in place from two months, as at Turkey Island, to fifteen days, as at Hacker's, their average duration being thirty-four days.

On the approach of winter the jetties were removed November 16 to December 5, the recovered panels and piling being stored for future use.

By the action of the jetties the channel was deepened at each of the bars named from 1 to 3 feet. At Stanton's, where the bar has been persistent for the past two years, 1 foot was gained, and the same was had at Hacker's, where the jetty was in place but a short time and where the river has very great width. At Schenimans 3 feet additional depth was obtained, slowly at first, but rapidly after a cut had once been established through the crest of the sand wave which seemed to have lodged at that place. The erosion at the other points lay between these limits, and the average was about 2 feet; nor at the close of the season was there left less than 7½ feet navigable water on any of these bars.

The corrugated steel panels used in 1895 were so successful that 8,000 linear feet more, slightly altered in design, were made and used last fall in the jetties named. The new panels are of the same length as the old, 10 feet, but are increased in width to 14 and 18 feet, and are made on I-beams instead of angle bars, which have proved weak. The corrugated metal was extended to within 1 foot of the ends of the beams and washers were used over the sheets with all rivets, greatly increasing the strength of the structure. These changes increased the weights of the panels from 1,000 to 1,200 and 1,600 pounds, in the two new sizes made, but they are still light enough to be easily handled.

The old panels were also used during the season, the angle bars having been reenforced by 3 by 6 inch oak beams.

To support the panels the use of flats, as in 1895, was discontinued as adding needless incumbrance to the plant. Instead, piles were driven in line at 5 to 20 feet intervals, according to depth of water and strength of current, and were connected by stringers lashed to them with light wire cables. Where deep scour occurred, and in repairs to lines where broken, the piles were driven in clumps of 2 or 3 sticks, as needed, but in general single sticks were used, driven as deep as possible, the penetration averaging 20 feet. At first the stringers were placed just above the water, but slight rises in the river so interfered with work that they were afterwards allowed to clear the surface by 12 to 18 inches.

The panels were attached directly to the stringers with lashings of three-fourths-inch rope, the tops of the beams resting on the stringers and their lower ends on the river bottom above the line of the piling, the slope of the panel depending on the depth of water in which placed. In shoal water the old small panels were used and the new larger sizes in greater depths, the selection of the proper panels from the barges occasioning slight delay, which in future may be avoided by having all panels of the maximum size required. In shoal water this will give them a very flat slope, but it is not a disadvantage.

The first jetties placed this year at Turkey Island and Seventy-six Landing were built without protection to the river bottom, and such scour occurred in the deep water as to break the lines in several places. Some scour had been anticipated, and to prevent the panels as they worked back from swinging through under the stringers, a lower stringer of very heavy poles was placed against the upper side of the piling, about 3 feet from the bottom. This arrested the panels in a vertical position and immediately directed such a stream of water against the bottom at the base of the piling that it was quickly scoured so deeply as to weaken the latter, and the line gave way. After this experience the use of the secondary stringer was abandoned, the panels were allowed to swing through, and, being partly lifted by the current, did much less damage and were afterwards reset. On all the other jetties the bottom was protected by mattresses 3 to 6 by 10 feet, made of brush fascines, one mattress loaded with stone being attached to each panel before it was placed. They were very efficient and in the three lower jetties, Schenimans, Goose Island, and Hacker's, no break occurred. At Stanton's, however, both lines were broken and the west jetty was repaired by placing a mattress 140 by 16 feet of fascines across the break in 18 feet of water and resting the ends of the panels upon it. The fascines were made of young willows bound with hide rope in 6-inch bundles, the brush being cut on the bars near each work.

Some delay in the rate of construction is made in attaching the mattresses to the panels, but immunity from scour is so essential as to overbalance it. To sink light woven mats in long lengths previous to placing the panels, somewhat as in the repairs to the Stanton west jetty referred to, is probably quicker, but will involve a slightly increased plant (way flats, etc.) and force, both of which are undesirable. The plant used with each party (there were two parties in the field, one working from Turkey Island to Schenimans, the other to Goose Island and Hacker's) was a full tow for any of the towboats, and as it was constantly moving from place to place it was essential to keep it below this limit. Plant for one party consisted of 3 pile drivers, 1 derrick boat, 6 decked flats, 1 steam tender, 1 barge of pile timber, 1 barge of panels, 1 fuel barge, 1 large quarter boat, and a crew of about 55 men The rate of construction for each party was about 150 feet of jetty per day. At the close of the season the rate of removal was 50 per cent greater.

Three lines—Turkey Island, Stanton eastjetty, and Seventy-six Landing (the first and last without mattresses)—were all started from the east bank of the river and projected across channels deeper than 10 feet leading into side chutes part of whose waters they were intended to divert into the steamer channel. In each instance the jetty was broken for 100 to 200 feet in the deep water, and although clumps of piles at short intervals succeeded in holding a repaired line in 18 feet depth at Stanton west jetty, yet this seemed to indicate that the limiting pressure for the light structure used was reached in about 10 feet of water and that to sustain the pressures due to greater depths the structure must become much heavier and more expensive. The lower jetties (Schenimans, Goose Island, and Hacker's), were all unbroken. They were protected at bottom by facine mats and were located on bars in mid-river, in depths from 3½ to 10 feet, and served to bring the crests of these bars to the water surface. Their effect was quite as marked as that of the jetties connected with the shore.

The head of water observed in the jetties did not exceed 6 inches, but the currents along their lengths and around their lower ends, next the shoals, were very strong. In each instance the line was given an inclination to direct this flow toward the shoal, but the pour was so close around the end of the jetty that its effect was to give width to the channel rather than to deepen it at a distance from the piling, the latter being accomplished by the damming action of the structure.

In removing the jetties 75 per cent of the piling and 93 per cent of the panels were re-covered, and 10 per cent of the latter will require repairs.

But few changes are suggested for the plant. The derricks should be set on the newer pattern drivers, as their hoists are quicker and stronger and have one more winch head than those on the old drivers. The derrick booms should be 45 feet in length, which is 5 to 10 feet longer than those in service last season. The running gear should consist of two whip lines, instead of one whip, and a double boom fall, all to be of 1½ inch manila rope, which will insure quick and safe working.

For drawing out piling at the close of the season the blocks used were much too light. Strains were noted as high as 15 tons on one driver, and 22 tons on two drivers, with water jets going in each case before the pile could be started. In order to do quickly such heavy, rough work, extra strong double and treble blocks for 5-inch lines should be provided.

Table of work done during the fiscal year ending June 30, 1897.

	Michael landing.		Ste. Genevieve, Ill.	Ste. Genevieve, Mo.			
	Hurdle No. 1.	Hurdle No. 2.	Hurdle No. 15.	Hurdle No. 8.	Hurdle No. 12.	Hurdle No. 14.	Hurdle No. 15.
Lengths of work projected........feet..	2,900	2,800	1,300	1,200	2,450	3,000	3,000
Equivalent lengths built..........do....	(*a*)	2,000	150	(*a*)	(*a*)	1,000	600
Piles driven..................number..	195	1,670	151			1,028	419
Piles driven, penetration..........feet..	8,383	33,428	2,398			17,458	7,045
Piles re-covered ....number..							
Braces placed.....................do....	3					45	
Stringers placed..................do....							
Foundation mattress fabricated and sunk.....................linear feet..		2,414				705	
Foundation mattress fabricated and sunk....................square feet..		306,863				81,600	
Drift mattress fabricated and sunk, linear feet..............................					650	1,265	860
Drift mattress fabricated and sunk, square feet..............................					19,200	47,050	24,250
Bank-protection mattress fabricated and sunk.....................linear feet..							
Bank-protection mattress fabricated and sunk....................square feet..							
Curtains placed..............linear feet..			230		270		1,800
Do....................square feet..			2,625		4,590		28,600
Stone revetment placed.....linear feet..	506			175	275		
Do....................square feet..	26,020			5,250	8,250		
Grading ....linear feet..							
Do....................cubic yards..							
Buttresses built...............number..					1	1	1
Panels placed ....do....							
Panels re-covered.................do....							

a Repairs.

Table of work done during the fiscal year ending June 30, 1897—Continued.

	Ste. Genevieve, Mo., bank protection.	Chester, Ill., bank protection.	Powers Island, Mo., hurdle.	Portable jetties.	Total.
Lengths of work projected........feet..	....	6,000	1,600	6,600	....
Equivalent lengths built..........do....	295	3,310	1,600	6,560	....
Piles driven....................number..	....	....	3,525	835	7,823
Piles driven, penetration..........feet..	....	....	65,353	16,800	145,865
Piles re-covered ....number..	....	....	....	592	592
Braces placed.....................do....	....	....	413	....	461
Stringers placed..................do....	....	....	....	209	209
Foundation mattress fabricated and sunk......................linear feet..	....	....	2,510	....	5,631
Foundation mattress fabricated and sunk ....square feet..	....	....	371,173	....	759,638
Drift mattress fabricated and sunk, linear feet..............................	....	....	4,421	....	7,196
Drift mattress fabricated and sunk, square feet	....	....	117,525	....	208,025
Bank-protection mattress fabricated and sunk......................linear feet..	295	3,310	....	....	3,605
Bank-protection mattress fabricated and sunk ....square feet..	24,970	413,750	....	....	438,720
Curtains placed.............linear feet..	....	....	1,450	....	3,750
Do......................square feet..	....	....	7,180	....	42,995
Stone revetment placed.....linear feet..	250	3,310	1,160	....	5,676
Do......................square feet..	7,500	75,560	49,850	....	172,430
Grading ....linear feet..	....	....	1,383	....	1,383
Do......................cubic yards..	....	....	4,870	....	4,870
Buttresses built................number..	....	....	....	....	3
Panels placed ....do....	....	....	....	670	670
Panels re-covered..................do....	....	....	....	621	621

Table of jetties, fiscal year ending June 30, 1897.

Location.	Lengths.	Dates of—		Channel depths when—		Gain in channel depth.		
		Placing.	Removal.	Placed.	Removed.	Total induration of jetty.	Due to oscillation on local gauge.	Due to jetty.
	Feet.			*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Turkey Island.....	1,150	Sept. 12–15	Nov. 16–20	6½	10	3½	¾	2¾
Stanton's East.....	1,000	Oct. 23–30	Dec. 2–5	5½	7½	2	1	1
Stanton's West....	460	Nov. 4–9	Nov. 28 Dec. 3	5½	7½	2	1	1
Seventy-six Landing	750	Oct. 1–8	Nov. 23–25	8	9½	1½	½	2
Shenimans.........	1,000	Oct. 14–20	Nov. 27–30	5	8	3	3/10	3
Goose Island	850	Oct. 17–21 Nov. 9–11	Nov. 23–25	6	8	2	½	1½
Hacker Island.....	1,350	Oct. 26–31 Nov. 2–6	Nov. 17–21	6	8½	2½	1½	1
Total........	6,560							

Location.	Local gauge at time of—		St. Louis gauge at time of—		Depths in which jetty was placed.
	Placing.	Removal.	Placing.	Removal.	
					Feet.
Turkey Island	*b* 142.75	*b* 143.50	171.70	172.90	4–15
Stanton's East	*b* 141.90	*b* 142.85	171.01	171.70	3–12
Stanton's West	*b* 141.90	*b* 142.85	171.01	171.70	2–8
Seventy-six Landing........................	*c* 115.35	*c* 114.75	172.85	172.55	4–12
Shenimans	*d* 7.5	*d* 7.7	172.25	172.10	3–6½
Goose Island................................	*e* 94.00	*e* 94.30	172.10	172.55	6–9
Hacker Island	*e* 93.15	*e* 94.50	170.80	172.90	4½–9½

a Channel depths taken from steamer leadline soundings.
b Little Rock.
c Grand Tower.
d Cape Girardeau.
e Commerce.

Table of material expended, fiscal year 1896–97.

	Michael Landing, Mo., hurdle.	Ste. Genevieve, Ill., hurdle.	Ste. Genevieve, Mo.		Chester, Mo., bank protection.	Powers Island, Mo., hurdles.	Portable jetties.	Total.
			Hurdle.	Bank protection.				
Subsistence, rations ...... number..	5,277	564	8,560	623	5,202	19,779	6,877	46,882
Brush ...... cords..	1,815.3	150	2,549.8	266.8	4,484.5	6,093.2	....	15,359.6
Piles ...... number..	1,868	104	1,350	....	....	3,875	243	7,440
Do ...... feet..	77,701	4,640	58,855	....	....	165,011	13,096	319,303
Stone ...... cubic yards..	3,424.9	442.7	7,093.1	543.6	6,886.2	15,519.3	120	34,029.7
Rople ...... pounds..	1,500	700	3,148	....	2,450	6,200	10,000	23,998
Wire ...... do....	4,706	985	12,396	550	9,700	27,505	7,800	63,642
Iron and steel ...... do....	81	....	275	....	....	381	30	767
Nails ...... do....	1,740	....	....	....	....	86	....	1,826
Spikes ...... do....	4,510	555	4,050	170	4,550	11,352	600	25,787
Screw bolts ...... number..	....	....	55	....	....	720	....	775
Do ...... pounds..	....	....	330	....	....	4,664	....	4,994
Clevises ...... number..	....	....	44	....	....	356	....	400
Lumber ...... feet..	800	....	336	....	500	1,200	1,106	3,442
Coal ...... bushels..	5,431	300	6,695	30	1,356	15,016	13,566	42,394
Coal, blacksmith's ...... pounds..	200	....	25	....	....	575	....	800
Ice ...... do....	84,000	10,000	155,000	10,000	56,000	290,050	65,620	670,670
Miscellaneous material	$38.46	$5.00	$145.17	....	$80.00	$384.30	$300.56	$953.49

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

REPORT OF MR. JOHN O. HOLMAN, ASSISTANT ENGINEER, ON SURVEY AND GAUGES.

ST. LOUIS, MO., *June 30, 1897.*

MAJOR: I have the honor to submit the following report of the survey between Red Rock and Cairo, and in connection therewith a report on gauges, test borings at Grand Tower, and low-water discharge measurements at St. Louis.

The survey consisted of triangulation, topography, and hydrography. The triangulation was carried only from Thebes to Cairo. Most of the stations were situated on the main banks of the river, and where likely to remain permanent for several years were marked by a gas-pipe hub 1¼ inches in diameter, covered by a cast-iron cap lettered U. S. The permanent stations on the rock shore between Commerce and Thebes were marked by a triangle cut in the stone with hole drilled in center. The main chain of the triangulation between Thebes and Cairo is composed of 90 stations connected by 10 single triangles and 44 quadrilaterals. Thirty-three of these stations are permanent. Eight more permanent stations back from the river bank are located by auxiliary triangles, and 8 objects, such as spires, chimneys, and flagstaffs, are located by intersections.

The instrument used was a Buff & Berger transit theodolite, 7-inch horizontal limb, with verniers reading to ten seconds. Angles were measured in order around the station, right to left direct and left to right reversed. Two sets on different parts of the limb were taken at each station, which gave 4 pointings and 8 readings on each target. In nearly all the sights the pole of the target could be bisected at its foot, doing away largely with errors in phase and plumbing of the target. The desired limit of the closure of the triangle was ten seconds, but extra sets had to be taken at several stations to obtain this result, as the work was carried on under nearly all conditions of weather.

The work depends on the secondary triangulation of the Mississippi River Commission. (Report Chief of Engineers, 1884.) The length and azimuth of the Dickey-Rouse line, in their fifth triangle above Cairo, and the geodetic coordinates of its extremities were used in the office reduction of the triangulation from Cairo to the connection with the Commerce-Hafner line in their sixteenth triangle above Cairo. The latter line was used as the base in computing the Commerce-Thebes stretch. Single triangles were adjusted to closure by giving equal weight to each angle, and the quadrilaterals were adjusted by the method given in Johnson's Surveying, pages

494–500. The discrepancies on the Commerce-Hafner line, as computed from the Dickey-Rouse base, are as follows:

Distance, plus	meters	0 .04
Azimuth, plus		14″.15
Latitude, plus		0″.00
Longitude, minus		0″.05

The topography was delineated by the plane table. The field work began at Commerce, and the field reduction of the triangulation between that point and Cairo and also between Commerce and Thebes was used in the projection of the plane table charts. The topography included the bar and shore lines and the general features within 200 to 500 feet of the bank on the main shore and large islands. The bluff contours and general topography not included by the survey was copied from the maps published by the Mississippi River Commission. Owing to the near approach of the winter season, the survey above Thebes was not as complete as below that point, except in the reaches between Cape Rock and Moccasin Springs and between Red Rock and Seventy-Six Landing. The survey above Thebes was based on the coordinates of precise bench marks, stone line benches, and flag stations published by the Mississippi River Commission.

The soundings on each map or plane-table chart were reduced to the average of the stages on the nearest gauge for the days on which the sounding was done. The soundings were taken in the low-water channel and in cross-section lines spaced about 1,000 feet apart; they were located by two transits set up at triangulation stations or at flag stations used in the plane-table work.

GAUGES.

There are 20 gauges now in service on the Mississippi River between the Ohio and Missouri rivers, of which 13 were maintained during the entire fiscal year. They are given below in their order downstream:

Location of gauge.	Miles from Eads Bridge.		Maintained by—
	High stage.	Low stage.	
Chain of Rocks, Missouri	9.7	10.2	St. Louis Water Department.
Bissells Point, Missouri	3.3	3.3	Do.
	Eads Bridge.		
St. Louis, Mo	0.4	0.4	Engineer Department, Vicksburg.
Supply Depot, Missouri	3.1	3.1	Engineer Department, St. Louis.
Jefferson Barracks, Mo	10.7	10.8	Do.
Waters Point, Missouri	21.3	21.8	Do.
Cornice Rock, Missouri	31.2	32.1	Do.
Brickeys Mill, Missouri	43.8	45.4	Do.
Little Rock, Mo	53.8	56.2	Do.
East Kaskaskia, Ill	62.7	66.1	Do.
Chester, Ill	69.5	73.0	Weather Bureau.
Bishops, Mo	78.1	82.1	Engineer Department, St. Louis.
Devils Backbone, Missouri	84.7	89.4	Do.
Grand Tower, Ill	98.6	103.4	Do.
Moccasin Springs, Mo	112.0	117.2	Do.
Cape Girardeau, Mo	125.5	131.1	Mississippi River Commission.
Grays Point, Mo. (Engineer)	130.6	136.6	Engineer Department, St. Louis.
Grays Point, Mo. (Commission)	131.8	137.8	Mississippi River Commission.
Commerce, Mo	138.6	144.6	Engineer Department, St. Louis.
Thompsons, Mo	156.7	163.8	Do.

The gauges at Thompsons, Commerce, Moccasin Springs, and Grand Tower were established during the present fiscal year. The latter gauge has been maintained several years by the employees of the Grand Tower Coal Company, but without level connection. The gauge at Devils Backbone was not fully established and is not included in the table of slopes given later. The Engineer gauge at Grays Point was abandoned in favor of the Mississippi River Commission gauge at the same locality, which had previously been abandoned by the Commission shortly after the establishment of the gauge at Cape Girardeau.

The survey of 1889 above Eads Bridge, the low-water plane-table survey of 1895 between that point and Bishops and the surveys of 1896 below the latter point were used in obtaining the gauge distances. The low-water distance was measured on the line of the low-water channel except at Grand Tower Island where the channel in the main river was used instead of the steamboat channel which passes back of the island during low stages. The high-water distance was measured on a line midway between the main banks in which the limit line of the contraction works, either constructed or projected, was used as the main bank of the river. The midway bank distance is 4.4 miles less between Eads Bridge and Cairo Point than given in previous tables, the difference arising partly from changes at Fish Bend and the head of Kaskaskia Cut-off and partly from the straightening of the channel due to the works of improvement.

Table of slopes between gauges at low and high stages during the fiscal year 1897.

	Slope in feet per mile. Stage on the St. Louis gauge.				Gauge oscillation from Nov. 1 to May 2.
	4.4.	24.8.	23.8.	30.9.	
	Nov. 1.	Jan. 7.	Mar. 28.	May 2.	
From Chain of Rocks	....	....	....	....	23.05
To Bissells Point	1.22	0.58	0.64	0.46	28.55
Thence to St. Louis	.18	.37	.45	.73	26.50
Supply Depot	.15	.24	.31	.65	25.15
Jefferson Barracks	.38	.48	.54	.66	23
Waters Point	.48	.58	.52	.56	22.30
Cornice Rock	.76	.58	.60	.57	24.50
Brickeys Mill	.52	.69	.60	.60	23.80
Little Rock	.54	.74	.70	.80	21.65
East Kaskaskia	.99	.63	.66	.53	26.65
Chester	.34	.73	.73	.75	23.90
Bishops	.46	.45	.45	.48	23.95
Grand Tower	.57	.60	.58	.64	23.10
Moccasin Springs	.58	.61	.56	.64	22.55
Cape Girardeau	.59	.54	.42	.51	23.80
Grays Point (Com)	.37	.67	.47	.60	22.50
Commerce	.22	.71	.34	.66	19.50
Thompsons	.77	.67	.18	.59	23.60
Cairo Point	.73	.64	.12	.45	....

The slope between the gauges at Cairo and Belmont on the dates given in the above table was accepted as the slope in the Ohio River below Cairo. The elevation of the water surface at Cairo Point found by this method was used in obtaining the slope below the gauge at Thompsons.

The second column is the slope at the crest of a quick rise when the slope below Commerce was not influenced by a high stage in the Ohio River. The third column is the slope at the crest of a wave which reached the mouth of the Ohio two days after the crest of the flood in that river, and shows the extent of the back water in the Mississippi. The fourth column is the slope at the highest stage on the St. Louis gauge in 1897 and after the subsidence of the flood in the Ohio. The last column is the oscillation at each gauge between the low reading of November 1 and the high of May 2.

The first column is the low-water slope at the stationary period which prevailed November 1, the lowest stage on the St. Louis gauge during the fall season. The large slope above Bissells Point and the small slope below remains about the same as in previous years. The greatest change is between Little Rock and East Kaskaskia, where the slope has been increased by the shortening of the low-water channel, the fall of 10 feet between these gauges remaining the same during the years 1893 to 1896. The low-water slope between Thompsons and Cairo Point varied from 0.91 when both rivers were low to 0.11 when the Ohio was high.

The low-water plane of the river immediately below St. Louis, which has been changing since the establishment of the gauges in 1891, continues this year with a decided change. The readings of 4.4, 3.4, 5.4, and 1.9 on the gauges at St. Louis, Jefferson Barracks, Waters Point, and Cornice Rock on November 1 of this fiscal year have been reduced by 1.4 feet in the following table:

Low-water gauge readings 1891 to 1896.

	1891.	1892.	1893.	1894.	1895.	1896.
St. Louis	4	3.72	3.18	2.50	2.30	3
Jefferson Barracks	4.03	3.65	2.73	1.50	1.05	2
Waters Point	4	4	4	4	4	4
Cornice Rock	4.15	3.77	2.43	1.90	1.05	.50

TEST BORINGS AT GRAND TOWER.

The borings at the head of Grand Tower Island were taken to ascertain the character of the river bed and the low-water channel depth which could be secured over the rock bottom by dredging the main channel of the river.

The borings were made with the jet pipe of a pile driver. The weight of the pipe, aided by the jet of water passing through it, easily penetrated most of the material encountered down to large bowlders or to solid rock. The depths at which the different strata of sand, gravel, gravel mixed with bowlders, and solid rock were encountered were noted by the "feel" of the jet pipe, i. e., the resistance and the sounds noticed by those handling the pipe.

The borings, 300 in number, were scattered irregularly over the rock ledge which extends across the river from the "bullheads," opposite Grand Tower, diagonally downstream to the head of the island. The borings developed a channel over the low part of this ledge not quite 300 feet in width and 10 feet in depth below the zero of the Grand Tower gauge, which could be secured by dredging material composed mostly of sand and gravel, with occasional beds of bowlders and hardpan, to an average depth of 9 feet. At low stages of the river the Grand Tower gauge registers 0.5 feet more than the St. Louis gauge.

DISCHARGE MEASUREMENTS.

The discharge measurements were taken near Sydney street, St. Louis, December 16 and 17, 1896. Previous measurements by this office give the following comparisons:

Discharge measurements in the vicinity of St. Louis.

Date.	Method.	Stage.	Width.	Area.	Velocity per second.	Discharged.
		Feet.	*Feet.*	*Sq. ft.*	*Feet.*	*Cu. ft.*
Dec. 14, 1880	Double floats	5.4	1,920	29,940	1.71	51,240
Oct. 25, 1895	.....do	2.7	1,855	22,040	2.20	48,000
Dec. 16, 1896	Rod floats	5.5	2,069	27,680	2.41	66,600
Dec. 17, 1896	.....do	6	2,062	29,810	2.40	71,500

Field operations covered a period of three months from September 1. The office force consisted of the assistant engineer in charge, 3 transitmen, and 3 rodmen, with a total of 31 in the party. This number was increased to 42 while taking the borings at Grand Tower during the month of November.

Very respectfully, your obedient servant,

JOHN O. HOLMAN, *Assistant Engineer.*

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A.

REPORT OF MR. E. D. LIBBY, ASSISTANT ENGINEER, ON PROCURING BRUSH AND STONE FOR WORKS OF IMPROVEMENT.

STE. GENEVIEVE, MO., *June 30, 1897.*

MAJOR: I have the honor to submit the following report of operations at procuring brush and stone during the fiscal year ending June 30, 1897:

PROCURING BRUSH.

At the beginning of the fiscal year two brush forces were in the field. Of these, brush force No. 1 was working at Eliza Towhead, and remained in that locality until September 14, when, in order to bring the party nearer the works of construction, it was moved to Liberty Island, where operations were carried on until instructions to disband the party were received. Active field work closed on October 16, and on October 21 the outfit, with the exception of derrick boat No. 1, was towed to winter harbor.

Derrick boat No. 1 was taken to the engineer depot for repairs.

Operations at procuring brush for the spring season were not commenced until June. Brush force No. 1 was reorganized on June 1, and on June 3 was taken to Turkey Island, where the procuring of brush was carried on until June 15. The ground being too soft for further work at this locality, the party was moved to the head of Fish Bend on June 15, where operations were carried on during the remainder of the fiscal year. Brush force No. 1 procured during the year 17,352.9 cords of brush. That which was obtained at Eliza Towhead was larger than has been used heretofore, and while no difficulty was experienced in handling it at the derrick boat, the work in the woods was very heavy, and this, in combination with the hot weather, caused no little trouble in maintaining a good working force of laborers.

The brush procured at Liberty Island was mostly of good size and quality for mattress building.

Brush force No. 2, at the opening of the fiscal year, was procuring brush at Fairy Island. From this locality it was moved, on July 14, to Moro Island, and on July 18 to Wilkinsons Island, where work was carried on until August 10. On August 11 the party was moved to Jones Point, where it remained until September 10, when the force was disbanded and the outfit was taken to Liberty Island, and from that place was taken to winter harbor with the outfit of brush force No. 1. This party procured 9,546.1 cords of brush.

With the exception of hot weather, the fall season and also the stage of the river that prevailed during the fall season were very favorable for obtaining brush at those localities where work was carried on. Heavy rains or any considerable rise of the river would have interfered seriously with the operations of brush force No. 1 at Eliza Towhead and Liberty Island, and of No. 2 at Jones Point.

On account of the high stage of the river during the early spring most of the land on which suitable brush is to be found was overflowed, and the ground was still very soft when operations began in June, but localities were found at which brush could be obtained in sufficient quantity to supply the works of construction.

During the fiscal year 26,899 cords of brush were procured.

PROCURING STONE.

During the months of July and August and until September 8 work at Little Rock Quarry was carried on with a force of about 140 men of all grades.

On September 8 instructions were received to disband the force. This was done as soon as the plant and tools had been properly taken care of.

The only work done during the winter and until June was to watch and care for the engineer property at the quarry.

On June 1 a small force was organized, and work was resumed and carried on during the remainder of the fiscal year.

Operations were confined throughout the year entirely to the lower quarry, the demand for stone not being sufficient to require an extension of the work to the upper quarry.

In the operations of quarrying during the fall season three steam drills were employed and were in constant service, steam for running them being supplied from the stationary boiler, from a pile-driver boiler, or from a portable boiler, as circumstances made most convenient.

Hand drilling was employed for block holing, and in locations not easily accessible with a steam drill.

During the fall season a very large part of the excavating was done by a water jet from a pile-driver pump. This method of removing the earth from the top of the ledge was found to be much more economical than by the use of shovel and pick.

With the small force employed in June only one steam drill was in service, and the pump used for excavating was not employed.

The loading of stone on barges was done entirely by steam derrick.

During the fiscal year there were procured 28,188.8 cubic yards of stone.

Very respectfully, your obedient servant,

E. D. Libby, *Assistant Engineer.*

Maj. Thos. H. Handbury,
Corps of Engineers, U. S. A.

REPORT OF MR. C. D. LAMB, SUPERINTENDENT UNITED STATES SUPPLY DEPOT.

St. Louis, Mo., *June 30, 1897.*

Major: I have the honor to submit the following report of operations at the supply depot during the fiscal year ending June 30, 1897.

The employees on the work July 1 included 31 carpenters, 8 machinists, and 32 laborers. This force was increased temporarily as the work required, but after the plant had been prepared for service in the spring it was reduced to 4 machinists, 20 carpenters, and about 25 laborers, besides the office force, watchmen, etc., and work was continued until the close of the year.

The work done upon the plant during the year is divided into four classes: Construction, equipping for service, extraordinary repairs, and ordinary repairs, which includes watching and care of property. Labor was also employed in handling materials and supplies of various kinds.

CONSTRUCTION.

Portable jetties.—The construction of jetties was begun in July and completed early in November.

Eight thousand linear feet was made in gates or panels each 10 feet long, 200 of these gates being 18 feet wide, and the remaining 600 each 14 feet wide, all of No. 14 corrugated iron riveted to steel I-beams 6 inches deep.

The beams for the smaller gates were 16 feet long and weighed 12½ pounds per linear foot, and they projected 12 inches beyond the corrugated iron on each side with clevises of one-half-inch iron in each end for convenience in handling.

The larger gates were made in the same way, but the beams were 20 feet long and weighed about 15 pounds per foot.

All of the iron used was painted with one coat of red oxide of iron, and another coat was applied to the finished gates.

The cost of these jetties on board a barge ready for use was about $19 per square, or $26.60 for each of the 14-foot and $34.20 each for the 18-foot gates.

About 750 of these gates were sent out for service and returned at the close of the season. Many of them were found so buckled and twisted by the strains to which they were exposed that they must be taken apart and straightened, and it seems advisable to stiffen them by channels or plates across the ends of the beams. This work could be done at a cost of about $5 per gate and would greatly increase their strength.

The gates made in 1895 of No. 16 iron were badly torn, and many of the sheets can not be made suitable for use, and should be replaced with new ones of No. 14 iron or even heavier if it can be procured.

Tools and appliances.—Three derricks were made and set up on pile drivers Nos. 7, 15, and 19 for handling portable jetties. They were made of different sizes, the most satisfactory for the purpose having a 35-foot mast and 45-foot boom.

Tools of all kinds were made for use on the plant as required, including blocks, fire tools, chains, cant hooks, jackscrews, etc.

EQUIPPING FOR SERVICE.

Dredge No 1.—This was designed for use as a jet dredge, and was equipped on barge No. 142, the cabin being built here, and most of the machinery purchased. It was pulled out on the ways during the last fiscal year and strengthened by the additional fore and aft bulkheads and heavy oak boiler beams.

The cabin was 90 feet long, 20 feet wide, and 12 feet high, with skylights and canvas roof.

The jets are furnished by two centrifugal pumps, 36 inches diameter, with suctions 15 inches in diameter located on the side of the barge amidships.

The discharge pipes are each 15 inches in diameter and run parallel to each other back to the stern, where they are divided into two 12-inch streams and pass through flat nozzles with openings 3½ by 18 inches.

Each pump is driven by an "Ideal" engine with a 14 by 15 inch cylinder coupled to the shaft and taking steam from a battery of two boilers of ordinary marine type, each 42-inch diameter by 28 feet long.

The dredge is lighted by a "Brush" focussing headlight, and 3 "Adams Bagnel" arc lights, all of 2,000 candlepower, with 24 incandescent lamps in the cabin.

The current for these lights is furnished by a 9 kilo-watt quadripolar "Western" dynamo, driven by a 7 by 10 inch "Ideal" engine.

Two hoisting engines with 7 by 10 inch cylinders, taken from pile-drivers Nos. 18 and 21, are set up on the stern for use with the derricks in handling the discharge pipes, and a "Providence" capstan with 5 by 7 inch cylinders on the bow for use in pulling the dredge into any desired position.

Dredge No. 2.—This dredge is equipped on barge No. 143 which is of the same size, and strengthened in the same manner as No. 142, but the cabin is built 2 feet wider than that of dredge No. 1. It is designed for use as a suction dredge; the material removed being drawn through the pump and carried away in the discharge pipe.

It is furnished with one centrifugal pump 48 inches in diameter, with a 20-inch supply pipe, receiving over the bow through 4 flattened cast-iron intakes, each about 5¼ by 30 inches wide.

The discharge 20-inch diameter at the pump was enlarged to 24 inches and run back through a swivel pipe at the stern into iron pipe carried on flats. Five hundred feet of this pipe is used, coupled together and connected to the dredge by short pieces of 24-inch hose.

A hoisting engine with 7 by 10 inch cylinders taken from pile driver No. 16 is set up on the bow. The drum shaft was taken out and replaced with a plain shaft carrying a winch at each end, for use in handling suction pipes. A "Providence" capstan with 5 by 7 inch cylinders is set up on the stern.

The pump is driven by a direct connected, compound, condensing engine with a 12-inch high and 25-inch lowpressure cylinder and 18-inch stroke.

Steam is furnished by 3 boilers, which, with the electric light plant, are similar to those on dredge No. 1.

EXTRAORDINARY REPAIRS.

Barges.—Extensive repairs were made during the year upon barges Nos. 102, 103, 105, 108, and 113. They were pulled out upon the ways and the rotten side plank, top timbers, decking, deck beams, stems, kevels, bits, chocks, and timberheads removed and replaced with new.

The bottom, sides, and decks were calked, the sides painted, and the barges launched for service.

No. 101 was pulled out during the fall and remained on the ways at the close of the year, and with Nos. 104, 110, and 111 will need the above-mentioned repairs to render it fit for service.

ORDINARY REPAIRS.

Steamer Gen. H. L. Abbot.—A pair of spuds were made during the fall season and set up alongside the derricks, by which the boat can be held while dredging in shoal water. They were made of white oak, 16 inches in diameter, and could be raised by blocks fastened to the top of the derrick mast. They work well in practice, though it may be found necessary to replace them with larger sticks.

A discharge pipe, 6 inches in diameter, was carried from each of the large pumps back to the stern and passed down through the ports between the rudders so as to strike the bed of the river at about the same point as the current from the wheel.

The rudders were repaired at intervals during the fall season. The starboard rudder was entirely rebuilt, while the stocks of the other two were renewed. The stocks were made of oak 14 by 16 inches, but as they seem unable to withstand the strains to which they are subjected, iron stocks were made during the winter of 13-inch pipe five-eighths inch thick, with stiffening plates of 1 by 12 inch steel.

A suction pipe 60 feet long and 12 inches diameter, of sheet iron, was made for the large pumps, put together in short pieces, with two flexible joints, of the bellows pattern, suitable for pumping out barges or other sunken plant.

The cylinder of the steam steering gear was cracked during the fall; it was taken out in the spring, and replaced with another of the same size, but made of flange steel five-eighths inch thick which will probably withstand any strain to which it will be subjected. This cylinder and its steam pipe was protected with sectional covering.

Steamer Gen. T. L. Casey.—A pair of iron spuds were set up alongside the derricks to hold the boat while washing with the wheel. They are of 10-inch steel pipe five-eights inch thick, and pass down through heavy cast-iron shoes in the guards.

A set of bronze packing rings was fitted to the main engines. A blistered sheet in one of the main boilers was replaced with a new one and a broken stay bolt repaired.

A new plummer block was put under the starboard end of the shaft. The furnace was repaired during the fall. The breeching was repaired in the spring, new fire liners put in, and the furnace walls relaid.

The port rudders were renewed during the fall. Small repairs were made upon the nosing, chocks, etc., and the outriggers were calked as required.

The canvas on the roof was renewed and painted two coats during the spring, and the cabin was painted throughout, with the exception of the small staterooms.

Steamer Gen. Gillmore.—The old "Brush" dynamo, wound only for arc lights, was taken out during the fall and replaced with a 9 kilo watts "Western" machine capable of running the old arc lights as well as the 35 incandescent lamps put in with the dynamo. The engine is small, but seems able to do the work required.

The old canvas on the roof was removed at the winter harbor, the ceiling patched and new canvas put on. The boat was brought to the depot in April and all necessary repairs made. The work done included the renewal of the entire head, fantails, pitmans, both guards, with exception of some of the outriggers, one main hog chain brace, the beds of the pumps' doctor, and dynamo, parts of the boiler deck, the port pillow block, the exhaust pipe from the engines to the heater, the cam yokes with brackets, and the doctor valves.

The old felt covering on the pipes and drums was found crumbled to a powder, and it was replaced with a carbonate of magnesia covering.

The top sides and outriggers were calked and painted. The entire cabin was scraped and painted three coats.

Dredges.—The top sides of Nos. 1 and 2 were calked.

Tenders.—Small repairs were made upon all the tenders as required.

The Providence capstan on No. 4 became unserviceable and was replaced with a stronger and more durable one.

Tenders Nos. 3 and 4 were pulled out on the ways and breaks in the hulls repaired.

Nos. 1, 2, 6, and 7 were pulled out in the fall and repaired during the winter.

Nos. 6 and 7 were calked and launched in the spring, ready for service.

Barges.—The top sides of all the 66 barges, except those on the ways, were calked and repaired during the fall and again in the spring. The broken floor timbers in No. 137 were repaired with 28 crotch floors.

Quarter boats.—The top sides of Nos. 1 to 10 were calked twice during the year.

The canvas on the roofs of Nos. 1 to 6 was replaced with new, and painted. These boats were also painted two coats on the outside and one coat in the cabin.

The old wooden bunks in Nos. 4 to 7 were torn out and replaced with iron beds holding single mattresses of woven wire.

Office and survey boats.—The top sides of all were calked in fall and spring.

The canvas roofs of Nos. 1 and 2 were renewed and their hulls and cabins painted.

Pile drivers.—The iron leads on Nos. 2, 4, 5, 6, 9, 12, and 24 were found unsafe during the fall and replaced with wooden leads.

The hulls of Nos. 1, 5, 6, and 8 leaked badly during the fall, and they were pulled out on the ways, the rakes and parts of the gunwales were renewed, and the machinery repaired.

The hoisting engines were removed from Nos. 16, 18, and 21 during the fall for use on the dredges, but the remaining 25 drivers with hoists are in a serviceable condition.

Two of the old crab-frame drivers, Nos. 10 and 20, are now in use on the bank at the depot; the others, Nos. 8, 11, 7, 15, and 19, are available for use, though the last three have been equipped with derricks for handling portable jetties.

Derrick boats.—The sides of Nos. 1 and 2 were calked in the fall and spring.

No. 1 was pulled out in the fall, a break in the hull repaired, the engine overhauled, the roof re-covered with canvas, and the derrick repaired.

Machine shop.—A small engine lathe was purchased and set up during the winter. This was 6½ feet long, 14-inch swing, with all the necessary attachments.

The shop was raised about 4 feet, bringing the floor up to a 33-foot stage, and the inside was painted.

Small boats.—All the serviceable flats, yawls, and skiffs were repaired and sent out for service during the summer. A few were towed to the winter harbor, but 210 flats, 124 skiffs, and 11 yawls were brought back to the depot and pulled out on the bank.

Seventy-five flats were repaired, calked and launched, ready for service in the spring.

The repairing of skiffs was continued during the year. New sides of California redwood were put in 35 as required, and about 100 made ready for service in the spring.

Portable buildings.—The roof of 6½ sections on barge No. 29 was covered with new canvas, and repairs were made upon the roofs of those at the depot.

Portable jetties.—The jetties sent out for service were returned and piled up on the bank. The damaged sheets were removed during the winter and preparations made for replacing them with heavier iron.

Ways.—The ways were in constant use throughout the season; but will need extensive repairs in about a year. The outer ends are covered with mud by each rise in the river, and it seems advisable to rebuild them with a different incline extending out to the wharf line.

The following plant was pulled out for repairs during the year: Six tenders, 6 barges, 4 pile drivers, 1 driver hull, and 1 derrick boat.

Supply depot.—An iron shed 54 by 120 feet was built at the lower end of the yard to cover the lumber kept in stock. The frame was made of old Z-bars from unserviceable steel leads, and the roof of the bent and twisted sheets taken from portable jetties.

New sheets of light iron were purchased to cover the sides and ends, and the whole painted with red oxide.

The old shipping platform was found unsafe, and was replaced with a new one. This was made of cypress piling decked with yellow pine. It is 37 feet above low water at the west end, and 9 feet lower at its outer end, 190 feet from the wall, about on the City wharf line.

The two portable buildings near the office were taken down and set up in one building below the wall just north of the platform. Its floor was placed at a 36-foot stage, which gives about 6 feet of headroom underneath, sufficient space in which to store the castings kept in stock.

The blacksmith and sheet iron shops alongside the platform were raised to a 33-foot stage.

The iron roofs of all permanent buildings were painted.

Seven clumps of mooring piles were driven along the river front for fastenings.

A steam hammer was set up in the blacksmith shop, taking steam from the machine boat. It has a 400-pound ram with an 8 by 18 inch steam cylinder.

The bins and pigeonholes in the warehouse were increased to about 400, which hold the stock of pipe fittings, etc., required.

Tools and appliances.—All the tools necessary for use here and on construction works were repaired, stored, or issued as required.

Boarding outfit.—The laundry boxes, tables, benches, bunks, stovepipe, and other boarding outfit were repaired and handled as needed upon the works.

Materials and miscellaneous stores.—The subsistence stores, lumber, and all other material used on the works, except brush, stone, piles, and coal, were received, stored, and issued from the depot as required.

Very respectfully, your obedient servant,

C. D. LAMB, *Superintendent.*

Maj. THOS. H. HANDBURY,
Corps of Engineers, U. S. A

W 3.

IMPROVEMENT OF HARBOR AT ST. LOUIS, MISSOURI.

St. Louis Harbor has a length of about 18 miles, being divided into two nearly equal parts by the Eads Bridge. The upper portion of the harbor between this bridge and the northern limits of the city is about 10 miles in length. About 3 miles above the Eads Bridge is the Merchants' Bridge. The lower portion of the harbor, included between the Eads Bridge and the River Des Peres, is about 8 miles long. A good depth of water and accessible landings exist in this lower part of the harbor, and a sufficient depth is found above the Merchants' Bridge.

Between the Merchants' and Eads bridges there had existed for a considerable number of years middle bars, and also shoals near the Illinois shore, which interfered with navigation and which will be mentioned again further on.

Appropriations for improvement of St. Louis Harbor had been made as early as 1836, and a longitudinal stone dike was built at that time near the head of the present works by Capt. R. E. Lee, Corps of Engineers. Other work done in later years by the United States consisted in the building of stone and brush dikes generally normal to the direction of the current, in the closing of Cahokia Chute, and the protection of the bank in Sawyer Bend.

The river and harbor act of Congress approved September 19, 1890, contained an appropriation of $182,000 for improving harbor at St. Louis, Mo., and the officer in charge, in submitting a project for its expenditure, recommended that the money be applied to the portion of the harbor between the Eads and Merchants' bridges. The approved project consisted in contracting this portion of the river to a width of about 2,000 feet by means of a system of hurdles built along the Illinois shore for a distance of about 13,000 feet, with a view to removing the bars which then existed and which interfered with navigation at low stages of the river, and also to improve the ferry landings on the Illinois shore. The object of the hurdles was to cause deposits of

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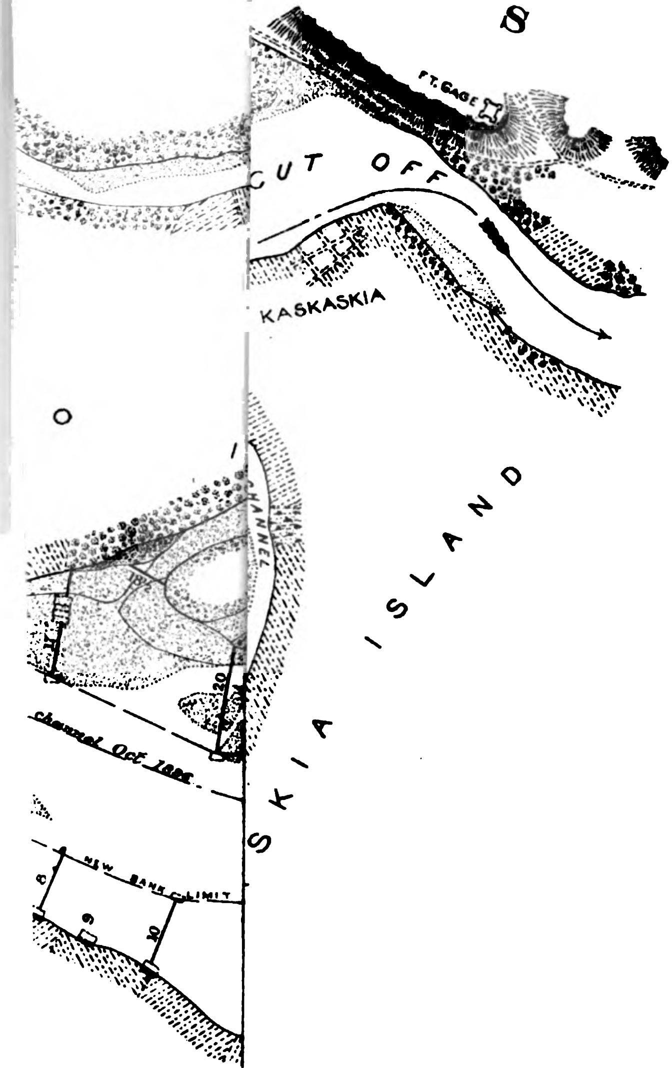
PLATE III.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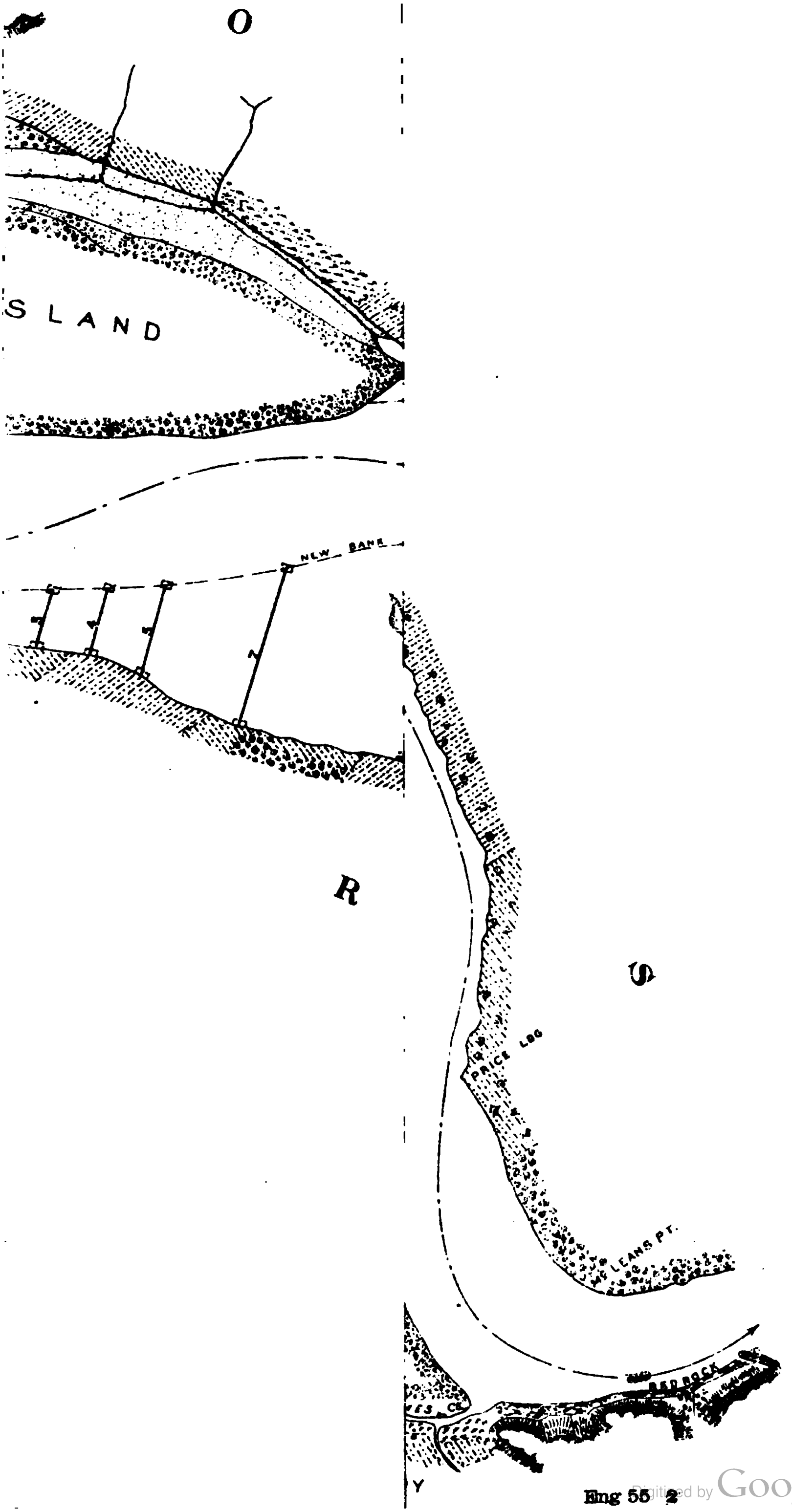

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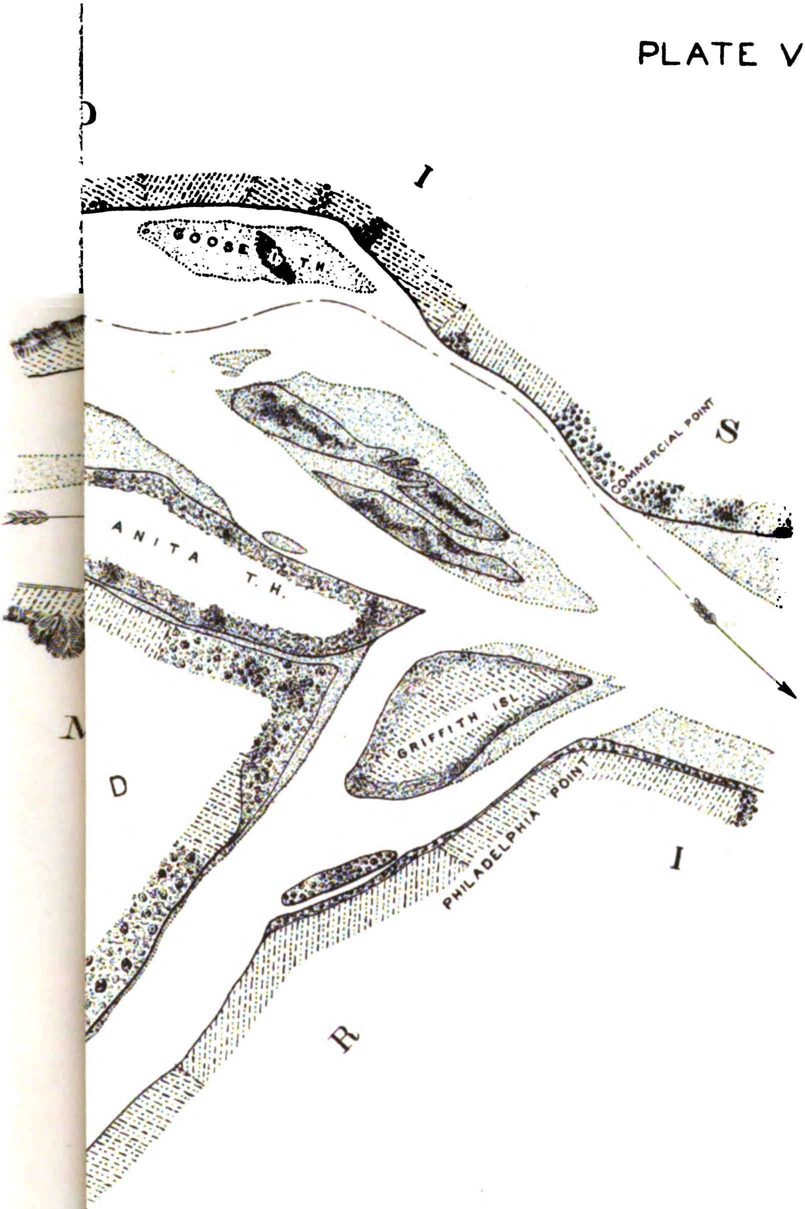

U. S. Engineer Office, Custom House, St. Louis, Mo.
Chief of Engineers, U.S.A., with Annual Report for
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Thos. H. Handbury
Major Corps of Engineers, U.S.A.

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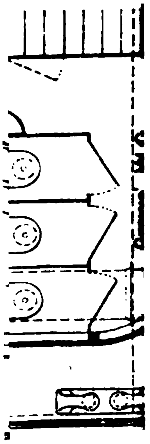

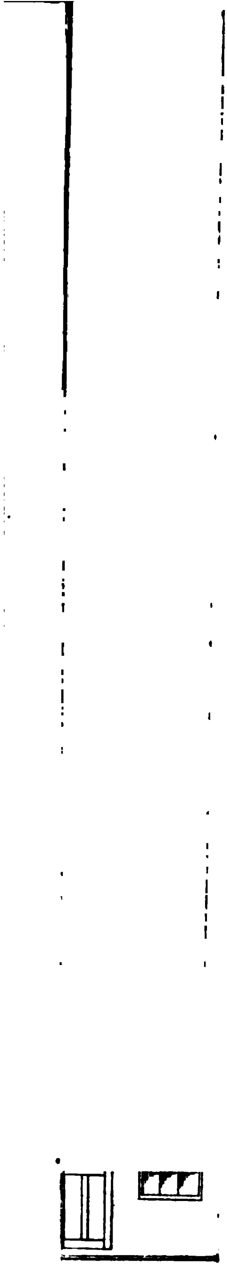

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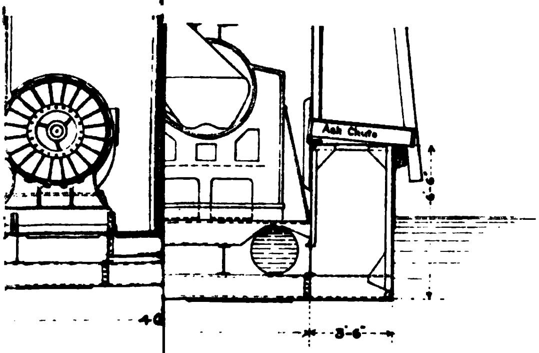

ON SHOWING

U.S. Engineer Office, Custom House, St. Louis Mo
Sent to Chief of Engineers, U.S.A with Annual Report for fiscal year ending June 30, 1897.

Th. H. Handbury
Major Corps of Engineers U.S.A.

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T. H. Handbury
Major Corps of Engineers U.S.A.

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sediment, and thus build up a new bank out to the line desired. They were twelve in number and spaced 1,000 feet apart. The hurdles, which were completed by July 1, 1892, were from 325 to 2,075 feet long. A full description of the manner of doing this work and the results obtained have been given in previous annual reports.

The navigable depth in the channel of the harbor between the line of hurdles and the opposite wharf line of St. Louis was in December, 1893, 11 feet, the river standing at zero of the gauge, which is 4 feet below standard low water.

The amount expended to June 30, 1896, was $150,762.03. There were no expenditures during the last fiscal year.

The hurdles remain in fair condition, except that the extreme river ends are weakened each year by drift and gradual decay of the pile timber. Repairs will be needed shortly.

The balance, $31,237.97, remaining from the appropriation of 1890 has been reserved to repair damages that may occur to the hurdles and to extend them when necessary.

No further appropriation is asked for this work.

The commercial statistics pertaining to this portion of the river will be found in the report on the improvement of the Mississippi River between the mouth of the Ohio River and the mouth of the Missouri River.

This work is in the collection district of New Orleans. The nearest port of entry is St. Louis, Mo., at which place the customs collected during the fiscal year ending June 30, 1897, amounted to $1,139,723.86.

The amount of internal revenue collected was $6,825,959.28.

Money statement.

July 1, 1896, balance unexpended	$31, 237. 97
July 1, 1897, balance unexpended	31, 237. 97

Appropriation.

By act of September 19, 1890	$182, 000

W 4.

TO PREVENT THE MISSISSIPPI RIVER FROM BREAKING THROUGH INTO THE CACHE RIVER AT OR NEAR A POINT KNOWN AS BEACH RIDGE, A FEW MILES ABOVE CAIRO, ILLINOIS.

The sundry civil act approved June 4, 1897, contains an item which reads as follows:

> For the purpose of preventing the Mississippi River from breaking through into the Cache River at or near a point known as Beach Ridge, a few miles north of Cairo, whereby the National Cemetery at Mound City, at the mouth of the Cache River, and the Marine Hospital at Cairo would be in imminent danger of destruction, the sum of one hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be immediately available.

The information on which this appropriation is based was obtained by Congress through sources other than the Engineer Department.

I have not been informed what the project for carrying on the work is or what the estimate of its cost may be. From a study of the conditions involved it would seem that the object of the appropriation can best be carried out and the wishes of those who were instrumental in obtaining it can best be met and their fears allayed by revetting as great a length of the bank of the Mississippi River in the vicinity of Beach Ridge Railroad Station as the funds will suffice.

A project for the expenditure of the $100,000 appropriated, based upon the idea expressed above, was submitted to the Chief of Engineers June 30, 1897, the work to be done by use of the Government plant provided for other localities and hired labor, the material to be purchased by contract, continuous or otherwise, and in open market, as may be most economical and advantageous to the Government.

No work has been done and no part of the funds have been expended.

Money statement.

Amount appropriated by sundry civil act approved June 4, 1897	$100,000.00
July 1, 1897, unexpended	100,000.00

Appropriation.

Act of June 4, 1897	$100,000

APPENDIX X.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS, AND OF GALENA RIVER, ILLINOIS.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Operating snag boats and dredge boats on Upper Mississippi River.
2. Mississippi River between Missouri River and Minneapolis.
3. Operating and care of Des Moines Rapids Canal and Dry Dock.
4. Operating and care of Galena River improvement, Illinois.
5. Construction of Lock and Dam No. 2, Mississippi River, between St. Paul and Minneapolis.

SURVEYS.

6. East bank of Mississippi River between Oquawka and Dallas City, Illinois.
7. East side of Mississippi River between Drurys Landing and New Boston, Illinois.
8. La Crosse Harbor, Wisconsin.
9. West side of Mississippi River from Lagrange to railroad bridge above Hannibal, Missouri.
10. Egyptian Levee, Missouri, along south bank of Des Moines River and west bank of Mississippi River at Alexandria, Missouri.
11. West side of Mississippi River from above Fort Madison to mouth of Skunk River, Iowa.
12. West bank of Mississippi River from mouth of Iowa River to Muscatine, Iowa.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 10, 1897.

GENERAL: I have the honor to transmit herewith the annual reports upon the works in my charge during the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

X 1.

OPERATING SNAG BOATS AND DREDGE BOATS ON UPPER MISSISSIPPI RIVER.

The work performed under this appropriation is the removal of snags, wrecks, rocks, and other obstructions to navigation.

The plant belonging to this work consists of the snag boats *General Barnard* and *J. G. Parke*, the latter of which has been used as a towboat for several years. Dredges are borrowed from other appropriations.

The operations of the snag boats and dredge boats extend from Minneapolis to the mouth of Missouri River, about 724 miles.

The snag boat *General Barnard* was engaged in the work of removing snags, etc., from March 26 to November 13, 1896, and from March 26 to June 30, 1897. Dredge *Vulcan* was employed during July and first week of August, 1896, in widening channel in Coon Slough and in removing obstructions in vicinity of Wilds Landing. Dredge *Phœnix* was employed a few days in September, 1896, in removing some old dams in vicinity of Cincinnati Landing and Marion City. In May and June, 1897, dredge *Phœnix* and Drill Boat No. 6 removed some ledges of rock from channel in vicinity of Fox River and Keokuk.

The details of work accomplished are given in appended report of Assistant Engineer C. W. Durham.

The total tonnage of the Mississippi River between the Falls of St. Anthony and mouth of the Missouri River for the calendar year 1896 was, approximately, 2,250,000 tons. This includes logs and lumber, as well as ordinary merchandise.

Money statement.

June 30, 1897, amount drawn from Treasury under permanent appropriation	$25,000.00
June 30, 1897, amount expended during fiscal year	25,000.00
July 1, 1897, amount available, under permanent appropriation of August 11, 1888, for fiscal year ending June 30, 1898	25,000.00

Abstract of appropriations.

By act approved March 2, 1867	$96,000
By allotment from appropriation of July 25, 1868	26,000
By allotment from appropriation of 1869	35,640
By act approved—	
July 11, 1870	36,000
March 3, 1871	42,000
June 10, 1872	42,000
March 3, 1873	25,000
June 23, 1874	25,000
March 3, 1875	25,000
August 14, 1876	30,000
June 18, 1878	41,500
March 3, 1879	20,000
June 14, 1880	8,000
March 3, 1881	25,000
By act passed August 2, 1882	25,000
By act approved August 5, 1886	22,500
By act of August 11, 1888, for fiscal year ending—	
June 30, 1889	25,000
June 30, 1890	25,000
June 30, 1891	25,000
June 30, 1892	25,000
June 30, 1893	25,000
June 30, 1894	25,000
June 30, 1895	25,000
June 30, 1896	25,000
June 30, 1897	25,000
Total	749,640

STATISTICS OF COMMERCE AND NAVIGATION.

Lumber.—The most important business carried on in connection with the navigation of the Upper Mississippi River and its principal tributaries is the lumber trade, which gave employment in 1896 to about 60 towboats, valued at $600,000. Along the river from Minneapolis to St. Louis 100 sawmills were operated by 75 wholesale lumber firms, having an invested capital of about $50,000,000. Their manufactures in 1896 were: Lumber, 955,587,000 feet B. M.; shingles, 229,518,000; laths, 175,657,000.

In addition to the manufacturers there is a large number of retail or distributing firms.

Lumber manufacture, Upper Mississippi River Valley, 1896.

[Value about $26,000,000.]

Locality.	Lumber.	Shingles.
	Feet B. M.	*Number.*
Above Minneapolis	229,411,000	47,139,000
Minneapolis	307,179,000	62,126,000
St. Paul to St. Louis	516,230,000	119,748,000
St. Croix River	187,985,000	39,885,000
Black River	132,178,000	47,644,000
Chippewa River	229,129,000	104,882,000
Total	1,602,112,000	421,424,000

The larger part of the above was floated for greater or less distance on the Mississippi River, either as logs or lumber. The total product (excluding shingles and laths), if shipped by rail, would have loaded 133,510 cars of 12,000 feet each (about 20 tons), the quantity generally accepted by lumbermen as a carload. Supposing an average length of car of 35 feet, it would have loaded a train 885 miles in length, or 6,675 trains of 20 cars each.

Statement of distribution of lumber manufacture along the Upper Mississippi River, from Minneapolis to St. Louis, in 1896.

Locality.	Lumber.	Shingles.	Laths.
	Feet B. M.	*Number.*	*Number.*
Minneapolis	307,179,000	62,126,000	47,925,000
Hastings	7,050,000	2,000,000	1,000,000
Red Wing	4,337,000	2,001,000	958,000
Winona	97,500,000	32,700,000	35,669,000
La Crosse	132,178,000	47,644,000	22,743,000
Prairie du Chien	4,068,000	3,040,000	700,000
Guttenberg	9,000,000	3,500,000	1,000,000
Dubuque	35,600,000	4,870,000	5,352,000
Bellevue	3,027,000	....	1,154,000
Lyons	17,380,000	3,490,000	2,236,000
Clinton	70,568,000	6,791,000	10,410,000
Fulton	15,000,000	2,000,000	1,500,000
Moline	16,250,000	3,481,000	3,660,000
Davenport	26.500,000	3,825,000	4,600,000
Rock Island	41,150,000	6,750,000	9,000,000
Muscatine	57,800,000	12,000,000	13,950,000
Burlington	27,000,000	3,000,000	2,000,000
Fort Madison	11,000,000	7,300,000	2,000,000
Keokuk	9,000,000	4,000,000	1,800,000
Quincy	16,000,000	10,000,000	4,000,000
Hannibal	18,000,000	9,000,000	4,000,000
Total	955,587,000	229,518,000	175,657,000

Lumber manufacture on the Mississippi River, from St. Paul to St. Louis, for ten years.

Year.	Lumber.	Shingles.	Laths.
	Feet B. M.	*Number.*	*Number.*
1896	648,408,000	167,392,000	127,732,000
1895	870,299,000	278,420,000	185,616,000
1894	673,572,000	204,198,000	158,586,000
1893	811,576,588	285,897,000	190,394,800
1892	931,806,305	357,014,775	228,042,910
1891	814,228,707	332,666,750	207,722,350
1890	1,231,678,960	508,986,705	....
1889	1,044,555,298	463,132,700	....
1888	1,048,951,386	423,655,050	....
1887	988,361,094	368,239,750	....
Total	9,063,437,838	3,384,602,730	....

Steamboats and freight.—The principal steamboat lines on the Upper Mississippi River are the Diamond Jo Line, the Eagle Packet Company, and the Joy Lumber Line. There are also many independent boats carrying freight and passengers.

During the season of 1896 the amount of freight and number of passengers carried could not be accurately ascertained, but partial reports give 120,973 tons of freight and 227,451 passengers, not including those of ferry and excursion boats.

Taking into consideration the logs and lumber floated in the stream, the gross tonnage for 1896 was approximately 2,250,000 tons.

Statement of approximate tonnage of the Upper Mississippi River, Minneapolis to St. Louis, for ten years.

Year.	Tons.	Year.	Tons.
1887	3,500,000	1892	3,750,000
1888	3,750,000	1893 *a*	3,200,000
1889	3,500,000	1894 *b*	2,975,000
1890	4,200,000	1895 *b*	3,000,000
1891 *b*	3,300,000	1896 *a*	2,250,000

a Great business depression. *b* Very low water.

At St. Louis there were received in 1896 from the Upper Mississippi River, by boats, barges, and rafts, 61,165 tons merchandise, 64,535,400 feet pine lumber, 16,415,200 shingles, and 13,416,900 laths. There were shipped to points on the Upper Mississippi River 31,510 tons merchandise.

Arrivals at and departures from St. Louis during 1896.

Steamboats and barges from Upper Mississippi River arrived at St. Louis	564
Steamboats and barges departed from St. Louis for Upper Mississippi River	561

The following table affords a comparative view of the relative amount of navigation at various localities on the Upper Mississippi River for the last three years:

List of steamboats, barges, and rafts passing through various bridges.

Locality of bridge.	Steamboats.			Barges.			Rafts.		
	1896.	1895.	1894.	1896.	1895.	1894.	1896.	1895.	1894.
Hastings	584	726	709	147	693	900	166	146	116
Winona	3,329	3,745	3,715	925	1,444	1,422	1,098	1,325	1,172
La Crosse	2,608	2,822	3,017	977	955	883	739	1,085	903
Dubuque	1,268	1,358	2,132	882	977	1,128	428	406	428
Sabula	1,604	1,576	3,783	477	1,078	1,276	(*a*)	(*a*)	(*a*)
Clinton	2,793	2,308	2,052	370	467	667	*b* 166	501	*b* 292
Rock Island	2,836	2,930	2,100	425	821	613	356	564	509
Keithsburg	732	996	1,069	158	440	(*a*)	180	*b* 180	(*a*)
Burlington	1,589	1,645	1,462	515	692	572	313	336	187
Fort Madison	1,221	1,473	1,272	434	437	436	145	227	167
Keokuk	1,543	1,317	1,233	1,269	519	901	97	119	121
Quincy	1,396	1,787	1,757	458	488	640	111	122	131
Hannibal	987	1,381	1,792	498	1,447	1,193	129	372	177
Louisiana	652	1,008	704	823	745	488	28	34	46

a No record. *b* Partial record.

The following table shows the navigation during a period of nineteen years through Winona Bridge, at which point the traffic is the largest:

Statement of steamers, barges, and rafts passing Winona Bridge during nineteen years.

Year.	Steamboats.	Barges.	Rafts.	Year.	Steamboats.	Barges.	Rafts.
1878	2,948	1,115	863	1888	4,740	684	1,894
1879	3,760	1,362	1,889	1889	4,419	1,140	1,387
1880	4,593	883	1,392	1890	5,417	1,045	2,123
1881	4,739	575	1,717	1891	3,687	1,108	1,495
1882	5,627	942	1,939	1892	5,268	957	1,759
1883	4,893	828	1,352	1893	4,428	1,324	1,655
1884	4,992	905	2,007	1894	3,715	1,422	1,172
1885	5,126	848	1,973	1895	3,745	1,444	1,325
1886	4,570	974	1,860	1896	3,329	925	1,098
1887	4,309	1,600	1,100				

Internal revenue for the year ending December 31, 1896, collected in districts bordering on the Upper Mississippi River.

Locality.	Office.	Amount.
Minnesota	St. Paul	$2,383,073.69
Second Wisconsin	Madison	474,847.65
Third Iowa	Dubuque	165,875.82
Fourth Iowa	Burlington	279,832.95
Fifth Illinois	Peoria	14,646,472.82
Eighth Illinois	Springfield	10,587,830.37
Thirteenth Illinois	Cairo	670,519.10
First Missouri	St. Louis	6,566,750.19
Total		35,774,202.59

Customs revenue and tonnage for the year ending December 31, 1896.

Port.	Collections.	Tonnage enrolled.	Vessels.
St. Paul, Minn	$231,148.30	2,025.74	25
La Crosse, Wis		4,736.28	62
Dubuque, Iowa	8,218.09	6,474.89	24
Rock Island, Ill		7,715.00	74
Burlington, Iowa	17.48	817.08	8
St. Louis, Mo. *a*	1,020,159.64	114,613.24	192
Total	1,259,543,51	136,382.13	385

a Only a part of the St. Louis statement applicable to the Upper Mississippi.

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897.

No. of voucher.	To whom paid	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	July, 1896.							
1	Hess Bros	$28.59			$20.09		$8.50	
2	W. R. King	28.00				$28.00		
3	C. W. Durham	3.00	$3.00					
4	Thos. E. Schindler & Co	88.17			88.17			
5	.....do	17.78			17.78			
6	Hess Bros	34.50			31.40			$3.10
7	C. W. Suman	2.00						2.00
8	Henry Dart's Sons	5.35					5.35	
9	John O'Neil	32.00				32.00		
10	Wm. A. Sutor	55.00				55.00		
11	Hired men	1,288.00	75.00	$1,213.00				
12	Furlong Grocery Co	31.79			28.74		3.05	
13	J. Kieffer	29.60			29.60			
14	Gentskow Bros	145.00				143.00	2.00	
15	A. Weber Co	2.24						2.24
16	Wilkinson & Co	3.33						3.33
17	F. H. Ketcham	67.00				67.00		
18	Hired men	874.00	40.00	834.00				
19	.....do	113.33	20.00	93.33				
20	Sam West	36.75						36.75
	Total	2,885.43	138.00	2,140.33	215.78	325.00	18.90	47.42
	August, 1896.							
1	C. W. Durham	7.00	7.00					
2	John Torrance & Son	27.24						27.24
3	Fred Kroner Hardware Co	14.88					3.70	11.18
4	James McCord	19.42					19.42	
5	August Peters	17.14			17.14			
6	W. Sims	7.20			7.20			
7	M. S. Roster	29.57			29.57			

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	August, 1896—Continued.							
8	Frank Feeny	$47.05			$47.05			
9	John W. Powers	4.09			4.09			
10	John H. Rippe	22.16			22.16			
11	J. H. Scrogum	17.05			17.05			
12	The Pilot Steamboat Co	186.00				$186.00		
13	Harry Clark	45.00				45.00		
14	C. E. Macy	134.77				134.77		
15	.....do	66.00				66.00		
16	Streator and Third Vein Coal Co	106.06				106.06		
17	Van Patten & Marks	191.70			147.17		$44.53	
18	Hess Bros	15.27			11.27		4.00	
19	Thos. E. Schindler & Co	27.26			27.26			
20	J. W. Stewart	19.47					18.43	$1.04
21	C. W. Durham	7.00	$7.00					
22	Anchor Line Store	17.24					7.89	9.35
23	John Grundmeyer	17.15			17.15			
24	John Lowell	36.27			36.27			
25	Thos. E. Schindler & Co	25.61			25.61			
26	Hess Bros	16.28			16.28			
27	John O'Neil	32.00				32.00		
28	The Pilot Steamboat Co	93.00				93.00		
29	Hired men	1,262.67	75.00	$1,187.67				
30	Heaney Bros	54.60			46.80		7.80	
31	J. H. Scrogum	9.07			9.07			
32	Wm. A. Sutor	22.00				22.00		
33	F. H. Ketcham	46.90				46.90		
34	Hired men	290.00	20.00	270.00				
	Total	2,934.12	109.00	1,457.67	481.14	731.78	105.77	48.81
	September, 1896.							
1	C. W. Durham	5.30	5.30					
2	Crown Coal and Tow Co	117.00				117.00		
3	Gentzkow Bros	99.00				90.00		
4	C. E. Macy	55.00				55.00		
5	John O'Neil	16.00				16.00		
6	H. S. Cable	62.00				62.00		
7	John Paul Lumber Co	1.37					1.37	
8	Chas. J. Long	59.20			56.72		2.48	
9	Thos. E. Schindler & Co	24.84			24.84			
10	White & Co	23.65			23.65			
11	J. Kieffer	27.99			27.99			
12	J. H. Scrogum	10.60			10.60			
13	Chas. Kirchner & Bro	40.85			40.85			
14	Albert Kirchner	34.86			34.86			
15	C. W. Durham	4.25	4.25					
16	Wm. G. Block	54.00				54.00		
17	Anchor Line Store	119.72					119.72	
18	L. T. Biethan	36.00				36.00		
19	Standard Oil Co	10.94					10.94	
20	Thorne & Andrus	9.09			9.09			
21	Fred Miller	22.80			22.80			
22	R. H. Stillwell	7.50			7.50			
23	Hired men	1,106.00	75.00	1,031.00				
24	.....do	485.08	60.00	425.08				
	Total	2,433.04	144.55	1,456.08	258.90	439.00	134.51	
	October, 1896.							
1	The Ætna Powder Co	13.75					13.75	
2	N. Phillips	20.00				20.00		
3	F. H. Ketcham	33.50				33.50		
4	The Con. Coal Co. of St. Louis	112.13				112.13		
5	H. S. Cable	54.25				54.25		
6	C. C. Smith	65.95			56.95		9.00	
7	Schroeder & Zoller	95.36			95.36			
8	C. C. Smith	14.43			11.43		3.00	
9	Thos. E. Schindler & Co	14.30			14.30			
10	John Odell	6.00					6.00	

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	October, 1896—Continued.							
11	Geo. R. Merrell	$21.00				$21.00		
12	Wm. Ihrer & Sons	52.90			$44.05		$8.85	
13	George Boeck	53.04			53.04			
14	Standard Oil Co	8.64					8.64	
15	H. O. Browning	93.60				93.60		
16	W. R. King	72.80				72.80		
17	Hired men	857.00	$75.00	$782.00				
	Total	1,588.65	75.00	782.00	275.13	407.28	49.24	
	November, 1896.							
1	H. O. Browning	46.80				46.80		
2	A. Kammerer	29.42			29.42			
3	Hired men	417.16		417.16				
4	C. W. Durham	6.75	6.75					
5	W. R. King	28.80				28.80		
6	H. S. Cable	36.58				36.58		
7	Hired men	245.00	75.00	170.00				
	Total	810.51	81.75	587.16	29.42	112.18		
	December, 1896.							
1	Hired men	290.00	75.00	215.00				
	January, 1897.							
1	Hired men	295.81	75.00	220.81				
	February, 1897.							
1	Hired men	560.00	560.00					
2	.....do	290.00	75.00	215.00				
	Total	850.00	635.00	215.00				
	March, 1897.							
1	McElroy Iron Works Co	1.00						$1.00
2	Curtis & Co. Mfg. Co	97.89					97.89	
3	C. W. Durham	6.94	6.94					
4	Henry Balluff	4.78	4.78					
5	Mississippi Coal and Ice Co	29.00						29.00
6	J. W. Erman	20.25						20.25
7	Hired men	260.00	75.00	185.00				
8	.....do	265.17		247.00				28.17
9	Carson & Rand	7.44						7.44
10	Henry Dart's Sons	18.20					18.20	
11	W. H. Salisbury & Co	183.00					183.00	
	Total	893.67	86.72	432.00			299.09	85.86
	April, 1897.							
1	Kellogg-Birge Co	297.81			244.81		53.00	
2	C. W. Durham	9.75	9.75					
3	Irwin-Phillips Co	4.75						4.75
4	A. Weber Co	6.52					5.52	1.00
5	Mississippi Coal and Ice Co	2.40					2.40	
6	Price Bros	104.91						104.91
7	D. Tipton	5.28	5.28					
8	C. W. Durham	3.00	3.00					
9	John McCaffrey	61.04				61.04		
10	Young & McCombs	14.70					14.70	
11	J. W. Stewart	1.72						1.72
12	Hess Bros	35.89			31.09		4.80	
13	H. Schroeder	25.66			25.66			
14	T. Nodler	39.31			31.91		7.40	
15	E. G. Frazer	11.24					11.24	
16	Davis Company	13.95					13.95	
17	S. M. Reynolds & Co	23.83					8.60	15.23

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	April, 1897—Continued.							
18	Reid & Witter	$8.90					$8.90	
19	J. F. Oltmann	9.00					9.00	
20	Van Patten & Marks	159.49			$141.51		17.98	
21	D. Santo	23.04			23.04			
22	M. L. Boyles	8.66						$8.66
23	C. E. Macy	99.00				$99.00		
24	Wm. A. Sutor	55.00				55.00		
25	McIntosh & Jones	10.17			10.17			
26	J. Kieffer	30.99			30.99			
27	Thos. E. Schindler & Co	19.34			19.34			
28	Chas. J. Long	10.82			10.82			
29	H. S. Cable	142.38				142.38		
30	F. A. Millard	3.23						3.23
31	Whitebreast Fuel Co	42.83				42.83		
32	Levi Boardman	12.00				12.00		
33	Gentshow Bros	48.50			4.50	44.00		
34	C. W. Durham	7.50	$7.50					
35	Hired men	1,320.00		$1,320.00				
36	Moline Elevator Co	91.36						91.36
37	John McCaffrey	108.50				108.50		
38	H. Schroeder	10.81			10.81			
39	Hess Bros	11.55			11.55			
40	Hired men	819.01		819.01				
41	C. M. Simpson	11.88						11.88
	Total	3,725.22	25.53	2,139.01	595.70	564.75	157.49	242.74
	May, 1897.							
1	C. W. Durham	6.25	6.25					
2	Smith Hardware Co	1.33						1.33
3	D. Santo	52.64			52.64			
4	T. Nodler	8.85			8.85			
5	Charles Keller	7.11	7.11					
6	T. Nodler	20.66			20.66			
7	D. Santo	16.82			16.82			
8	Hired men	1,311.83		1,311.83				
9	.....do	1,335.00		1,335.00				
	Total	2,760.49	13.36	2,646.83	98.97			1.33
	June, 1897.							
1	Sam West	20.25					20.25	
2	W. S. Gray	30.25					30.35	
3	Whitebreast Fuel Co	94.82				94.82		
4	J. McCaffrey	100.66				100.66		
5	H. Schroeder	19.68			19.68			
6	S. Hamill Co	101.54			97.74		3.80	
7	D. Santo	98.28			98.28			
8	Pittsburgh and Lake S. Iron Co	114.75					114.75	
9	C. E. Macy	66.00				66.00		
10	Wm. A. Sutor	66.00				66.00		
11	Harry Clark	36.00				36.00		
12	Whitebreast Fuel Co	217.11				217.11		
13	Davis Co	16.50					16.50	
14	P. R. Sutton	18.00						18.00
15	Henry Dart's Sons	159.08			134.54		24.54	
16	Hess Bros	21.45			17.80		3.65	
17	.....do	21.35			21.35			
18	H. Schroeder	17.43			17.43			
19	Kellogg-Birge Co	66.31			63.31		3.00	
20	J. Nodler	17.99			17.99			
21	J. Kieffer	22.19			22.19			
22	J. H. Scrogum	9.75			9.75			
23	Flick & Co	4.90			4.90			
24	White & Co	4.45			4.45			
25	Ketterer & Koss	3.99			3.99			
26	J. McCaffrey	109.90				109.90		
27	Smith Bros	20.48			20.48			
28	T. Nodler	6.25			6.25			
29	Ketterer & Koss	3.42			3.42			

Detailed statement of expenditures for operating snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897—Continued.

No. of voucher.	To whom paid.	Total.	Office expenses, superintendence, and contingencies.	Labor.	Subsistence.	Fuel.	Expense.	Repairs.
	June, 1897—Continued.							
30	Jno. Lowell	$21.49			$21.49			
31	Jno. Grundmeyer	7.95			7.95			
32	The Con. Coal Co. of St. Louis	87.75				$87.75		
33	The Lammert Furniture Co	18.00					$18.00	
34	Anchor Line Store	79.53					79.53	
35	J. D. Lawnin	22.61						$22.61
36	Laflin-Rand Powder Co	73.68					73.68	
37	J. McCaffrey	150.78				150.78		
38	C. M. Wetherell	35.00						35.00
39	Chas. J. Long	23.67			21.27		2.40	
40	H. Schroeder	21.77			21.27			
41	D. Santo	40.20			40.20			
42	.....do	10.88			10.88			
43	H. C. Hodge & Sons	12.00			12.00			
44	R. H. Stillwell	8.00			8.00			
45	Wilkinson & Co	8.03					8.03	
46	W. S. Gray	25.78					25.78	
47	T. Nodler	17.21			17.21			
48	D. Santo	50.46			50.46			
49	J. Siegrist	4.13			4.13			
50	A. Weber Co	1.00					1.00	
51	Whitebreast Fuel Co	41.28				41.28		
52	Rendrock Powder Co	661.20					661.20	
53	Hired men	720.98		$720.98				
54	.....do	1,211.66		1,211.66				
55	.....do	603.67		603.67				
56	.....do	67.16		67.16				
57	Wrought Iron Range Co	5.05						5.05
58	T. H. Thomas	13.36					13.36	
	Total	5,533.06		2,603.47	778.91	970.30	1,099.72	80.66

Summary of expenditures for operating snag boats and dredge boats on Upper Mississippi River for fiscal year ending June 30, 1897.

Month.	Office expenses, superintendence, and contingencies.	Care, repair, and operating snag boats and dredge boats.						Grand total.
		Labor.	Subsistence.	Fuel.	Expenses.	Repairs.	Total.	
1896.								
July	$138.00	$2,140.38	$215.78	$325.00	$18.90	$47.42	$2,747.48	$2,885.48
August	109.00	1,457.67	481.14	731.73	105.77	48.81	2,825.12	2,934.12
September	144.55	1,456.08	258.90	439.00	134.51		2,288.49	2,433.04
October	75.00	782.00	275.18	407.28	49.24		1,513.65	1,588.65
November	81.75	587.16	29.42	112.18			728.76	810.51
December	75.00	215.00					215.00	290.00
1897.								
January	75.00	220.81					220.81	295.81
February	635.00	215.00					215.00	850.00
March	86.72	422.00			299.09	85.86	806.95	893.67
April	25.53	2,139.01	595.70	564.75	157.49	242.74	3,699.69	3,725.22
May	13.36	2,646.83	98.97			1.33	2,747.13	2,760.49
June		2,603.47	778.91	970.30	1,099.72	80.66	5,533.06	5,533.06
Total	1,458.91	14,885.36	2,733.95	3,550.24	1,864.72	506.82	23,541.09	25,000.00

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 1, 1897.

COLONEL: I have the honor to present my report on the operations of snag boats and dredge boats on Upper Mississippi River for the fiscal year ending June 30, 1897.

Operations of snag boat General Barnard.—The *Barnard* was in commission, for the purpose of removing snags and other obstructions between Minneapolis and mouth of Missouri River, from March 26 to November 13, 1896, and from March 26 to June 30, 1897. In addition to the usual work, a portion of the *Barnard's* crew was employed fifty days in September, October, and November, 1896, on levee surveys between Muscatine and Fort Madison. An examination of a rock ledge opposite Fort Madison was made in November, 1896, and of the harbors of Dubuque, East Dubuque and Muscatine in May, 1897. The boat was employed thirteen days in May and June, 1897, in repairing and strengthening levees between Keokuk and Quincy. During the winter of 1896–97, she lay in the Des Moines Rapids Canal above Middle Lock, and received small repairs before coming out in the spring.

Summary of operations of snag boat General Barnard for fiscal year ending June 30, 1897.

Snags removed	223
Leaning trees pulled back	70
Leaning trees felled	3,007
Wrecks removed	1
Buoys placed	17
Surveys made (days)	52
Repairing levees (days)	13
Miles run	7,527

Operations of snag boat J. G. Parke.—During the fiscal year the *Parke* was used as a towboat on construction work between Illinois and Missouri rivers.

Operations of dredge Vulcan.—During July and the first week of August dredge *Vulcan*, with towboat *Alert* as tender, was engaged in completing the widening of the channel at Big Bend in Coon Slough, and also in removing several dams and parts of dams in vicinity of Wilds Landing. Details of this work are given in report of Assistant Engineer W. A. Thompson. The amount expended on this work during current fiscal year was $1,787.92.

Operations of dredge Phœnix and tender.—Dredge *Phœnix* removed a short spur dam at head of Island 436 and portions of a submerged dam below Cincinnati Landing, the same having become obstructions to navigation. Details are given in report of Assistant Engineer S. Edwards. The cost of this work was $590.01.

Operations of drill boat No. 6 and dredge Phœnix.—Drill boat No. 6, tended by towboat *Mac*, commenced operations on April 16, 1897, in removing ledges of rock near Gregory, but owing to extreme high water it became necessary on the 21st to abandon this work for a time. The crews were then engaged in repairing and strengthening with sacks of gravel and sand portions of the Warsaw-Quincy Levee, which work was continued until May 3, when the drill boat resumed rock excavation near Gregory. On May 17, the breaking up of two large patches of rock in mid-channel having been completed, the plant was moved to Keokuk, and was there employed on the high-rock patch opposite the landing until June 12. On the 13th the plant was transferred to Fort Madison, where it was engaged until the 16th in shattering the higher points of a rock ledge opposite the Diamond Jo Landing.

Dredge *Phœnix* operated at Gregory in removing the broken rock from June 4 to 14, at which latter date she was transferred to sand-excavation work near Dallas, in connection with improvements being made there. The lower rock patch at Gregory has been removed, and also a portion of the upper. It is proposed to complete, by use of the dredge, the removal of the remaining broken rock at Gregory, and also that at Keokuk and Fort Madison later in the season. The area covered by the drill boat at Gregory was 5,044 square feet; at Keokuk, 10,752 square feet; at Fort Madison, 1,528 square feet; total, 17,324 square feet. In above work there were 1,124 holes drilled, of which 1,070 were blasted, 3,304 pounds of rackarock being used, resulting in the breaking of 987 solid cubic yards of rock. The dredge removed at Gregory 1,536 cubic yards of rock, sand, and gravel. The cost of rock excavation, as mentioned above and including the time spent in repairing Warsaw-Quincy Levee, was $5,854.58.

Operations of Dredge Ajax.—From June 1 to 9 the *Ajax* removed three cribs filled with rock, and some outlying piles of rock from the channel, at Clinton, Iowa, the same having been formerly used for mooring purposes at the Clinton Lumber Company's sawmill. The rock removed, amounting to 1,460 cubic yards, was placed as shore protection on head and sides of towhead near Island 290. This work was paid for from the general appropriation.

Summary of expenditures.

Snag boat *General Barnard*	$15,308.58
Dredge *Vulcan* and tender	1,787.92
Dredge *Phœnix* and tender	590.01
Drill boat No. 6, tender, and dredge *Phœnix*	5,854.58
Superintendence and office	1,458.91
Total	25,000.00

RIVER NOTES.

In 1896 the river above Keokuk remained at a good stage until the end of July, but from that time until the close of navigation was quite low. There were, at the lowest water, only three serious points of obstruction, all of which were improved during the season, but business was so bad that raft boats and packets laid up very early. Below Keokuk the river remained at a good stage, except for a few days in September and October, but there were no obstructing bars found during the season.

In 1897 the river to the present time has remained high and favorable to traffic.

An unusual rise, for the time of year, occurred in April, the river reaching a stage at St. Paul of 17.5 feet; at La Crosse, 13.7 feet; at Dubuque, 17.9 feet, and at Keokuk, 18.4 feet. A bad break occurred in the Hunt Levee, causing much damage and suffering. Construction work on the Flint Creek Levee was abandoned for six weeks.

Available channel depths, in feet, at the worst bars at low stages in 1896, as found by the snag boat General Barnard.

Between St. Paul and Lake Pepin (*61 miles*).—The *Barnard* found no bar on which there was not more than 4 feet.

Reeds Landing to Winona (*41 miles*).—Opposite Wabasha, 3.5; Grand Encampment, 3.5; head of Buffalo Chute, 4; mouth of Zumbro River, 4; above Minneiska, 4; above mouth of Beef River, 4.

Winona to La Crosse (*31 miles*).—Below Homer, 4; La Moille, 3 (later improved); below Trempealeau, 4; Queens Bluff, 4.

La Crosse to Prairie du Chien (*79 miles*).—Brownsville, 4; Heytmans, 4 (later improved).

Prairie du Chien to Le Claire (*153 miles*).—Below Finleys, 4; Deadmans, 4; below Bellevue, 3.5; Santa Fe, 4; Elk River, 4; Comanche, 3.5.

Rock Island to Keithsburg (*58 miles*).—Dodges, 4; at Buffalo, 3.5; below Buffalo, 3.5; Montpelier, 3.5; below Fairport, 4; above Muscatine, 4.

Keithsburg to Des Moines Rapids (*60 miles*).—Benton Island, 3.5; above Oquawka, 3.5; Drews Prairie, 4; foot of Burlington Bluff, 3.5; foot of Sauerweins Bend, 3.5; foot of Dallas Chute, 4; Pontoosuc, 4.

Keokuk to Missouri River (*184 miles*).—The *Barnard* found no water in the channel as shoal as 4 feet, but the stage remained somewhat higher during the season in this stretch of river than above Keokuk.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND MINNEAPOLIS.

Under this head of appropriations are carried on, chiefly, works for the permanent improvement of through navigation, but improvements at harbors and other localities are frequently made under allotments as provided for in the various acts of Congress. Additional remarks on the scope and character of the work, etc., may be found on pages 1775–1778, Report Chief of Engineers for 1896.

At the commencement of the fiscal year there was available the sum of $418,245.07.

On account of the comparatively small amount available and the diversion of a great part of the funds to special work, comparatively little was done on general improvement.

Under improved projects, work of dam construction, shore protection, dredging, and removal of rock, etc., has been carried on during the past year by hired labor and use of Government plant between St. Paul and Lake Pepin, at Kings Coulee, between Reeds Landing and Genoa, at Rock Island Rapids and Harbor, between Kiethsburg and Nashville, between Keokuk and Quincy, between Quincy and Clarksville, at Quincy Bay and Harbor, at Sny Island Levee, and between the Illinois and Missouri rivers. Under formal contract, between Genoa and Prairie du Chien, between Dubuque and Clinton, at East Dubuque Harbor, between Rock Island and Muscatine, between Hamburg and Cap au Gris, between Cap au Gris and the Illinois River, and at the Flint Creek and Warsaw levees.

I give below a brief synopsis of operations and of the condition of the various special allotments made by direction of Congress.

Harbor at Burlington, Iowa.—No work was done during the year, and there is an available balance of $3,094.38 remaining from the allotment in act of September 19, 1890.

Dredging Quincy Bay, Illinois.—The balance available on July 1, 1896 ($3,931.45) was expended during the year. The work was done by hired labor and use of Government plant and resulted in the removal of 55,540 cubic yards of material.

The river and harbor act of June 3, 1896, provides $15,000 for dredging the channel in Quincy Bay, which it is proposed to distribute over the three years, 1898, 1899, and 1900.

Warsaw to Quincy, Ill.—The sundry civil act of March 2, 1895, allotted $85,500 for raising, repairing, and strengthening the levees between those cities, and the funds have been used for those purposes. The amount of earthwork built during the year was 367,952 cubic yards, and 9,350 linear feet of bank was protected by revetment.

The river and harbor act of June 3, 1896, provides $5,000 for "repair and maintenance," which will probably be expended during the current year.

Flint Creek to Iowa River.—The sundry civil act of March 2, 1895, allotted $85,000 for constructing a levee from Flint Creek, near Burlington, Iowa, to a point up the Iowa River above high-water mark. The sundry civil act of June 3, 1896, added $75,000, and that of June 4, 1897, $50,000, making a total of $210,000.

The original estimate for this levee, made from the preliminary surveys, was $305,000. Subsequent surveys reduced the length of the levee about 7 miles, and the estimate to $250,000; so that $40,000 additional will complete the work. Twenty-two of the 36 miles are now finished. During the last calendar year 604,230 cubic yards earthwork was built and about 4,000 linear feet of shore protection in the Iowa River.

Harbor of refuge at Kings Coulee, Lake Pepin.—The river and harbor act of June 3, 1896, allotted $30,000 for a harbor of refuge at Kings Coulee, and plans were made to cover the amount appropriated. A pier or breakwater, about 800 feet long, will be built of dredged material, chiefly gravel, and covered with rip-rap rock. About 400 linear feet of this pier are now completed.

Harbor at La Crosse, Wis.—The act of June 3, 1896, allotted $5,000 for this harbor, and it was proposed to expend the same during past fiscal year. But the results of a survey ordered by the same act were such as to show that about $17,000 was needed to perform proper work, and that it would be better to reserve the $5,000 until further funds became available.

Harbor at East Dubuque, Ill.—The river and harbor act of June 3, 1896, allotted $5,000 for dredging, and the money was expended for that purpose. An area of 210,000 square feet was dredged over and 31,667 cubic yards of material removed, the work being done by contract at 15 cents per cubic yard.

Harbor at Rock Island, Ill.—The act of June 3, 1896, allotted $5,000 for this harbor, and the money was expended in rock excavation along the levee. About 300 feet of landing was put in excellent shape by the removal of 2,243 cubic yards rock.

Steamboat Landing at Quincy, Ill.—The act of June 3, 1896, allotted $10,000 for this harbor, and a project was rendered to cover the available funds. Work is in progress, and has thus far consisted in the construction of two low brush dams on the bar, a grundschwelle extension, 363 feet long, of Dam No. 1, and two cuts through the bar, the upper side of the upper cut being protected by rip-rap. About 42,000 cubic yards sand was dredged and removed.

Sny Island Levee.—The river and harbor act of June 3, 1896, allotted $50,000 to protect this levee, which extends along left bank of Mississippi River from Quincy to Hamburg, Ill. A project was made for the past fiscal year to cover the expenditure of $15,000 of above-mentioned allotment, and the levee slope on the river side at Kings Island was protected for a distance of 1,000 feet, and at Harris Island for 2,582 feet. It is proposed to expend $25,000 during 1898, and the remaining $15,000 during 1899 and 1900.

The details of the above-mentioned improvements are given in the appended reports of assistants in local charge.

Commercial statistics accompany my report on operating snagboats and dredge boats on Upper Mississippi River.

The improvement of the Upper Mississippi River has been carried on gradually, giving the river itself opportunity to assist in the formation of proper channels. It has been customary when funds are available to select for improvement such localities as were at the time most detrimental to navigation. Detailed plans for radical improvement have not as yet been determined upon, and the work has been hitherto prosecuted under general methods, the approximate estimate being $20,000 per mile, and the depth to be secured $4\frac{1}{2}$ to 6 feet at low water.

In my opinion $1,500,000 can be profitably expended during fiscal year ending June 30, 1899.

Summary of expenditures for calendar year ending December 31, 1896, under appropriations for improving Mississippi River, "Ohio River to Minneapolis," applied to that portion of the river between the mouth of the Missouri River and Minneapolis.

Minneapolis to St. Paul (Lock and Dam No. 2)	$9,145.87
St. Paul to Lake Pepin	14,915.68
Kings Coulee pier (Lake Pepin)	8,303.33
Reeds Landing to Genoa	40,542.25
Genoa to Prairie du Chien	30,877.23
Dubuque to Clinton	19,474.20
Harbor at East Dubuque	5,000.00
Rock Island Rapids	40,633.96

Harbor at Rock Island	$3,686.66
Rock Island to Muscatine	41,697.50
Flint Creek to Iowa River Levee	73,089.82
Surveys for levees, Drurys Landing to Hannibal	4,594.29
Keithsburg to Nashville	3,044.67
Keokuk to Quincy	30,213.11
Warsaw to Quincy Levee	45,355.09
Quincy Bay	4,659.87
Quincy Bridge to Clarksville	18,126.97
Quincy Harbor	4,837.72
Sny Island Levee	10,179.37
Hamburg to Cap au Gris	34,577.45
Cap au Gris to Illinois River	24,264.78
Illinois River to Missouri River	38,053.00
Surveys and gauges	270.06
Purchase, construction, care, and repair of plant	24,373.84
Total	532,916.72

NOTE.—In above statement retained percentages and delayed estimates on contracts December 31, 1896, are included.

Summary showing localities, amounts, and cost of regular construction works in 1896, between St. Paul and mouth of Missouri River.

Locality.	Method.	Material.		
		Rock.	Brush.	Total.
		Cubic yds.	*Cubic yds.*	*Cubic yds.*
St. Paul to Lake Pepin	Hired labor	4,623.7	4,584.7	9,208.4
Reeds Landing to Genoa	do	18,162.5	64,153	82,315.5
Keokuk to Quincy	do	23,973.3	24,499.6	48,472.9
Quincy to Clarksville	do	9,164	19,904.6	29,068.6
Illinois River to Missouri River	do	23,883.4	39,304.2	63,187.6
Genoa to Prairie du Chien	Formal contract	24,985.1	25,090.2	50,075.3
Dubuque to Clinton *	do	25,342.5	20,036	45,378.5
Rock Island to Muscatine	do	42,506.6	42,386	84.892.6
Hamburg to Cap au Gris	do	28,581.5	29,882.6	58,464.1
Cap au Gris to Illinois River *	do	40,350	42,100	82,450
Total		241,572.6	311,940.9	553,513.5

Locality.	Cost of work.	Average cost per cubic yard on barges.	Average cost per cubic yard for towing and putting in material.	Average cost per cubic yard for general superintendence, office expenses, and inspection.	Average cost per cubic yard for plant.	Average cost per cubic yard in place.
St. Paul to Lake Pepin	$8,029.75	$0.228	$0.495	$0.038	$0.111	$0.872
Reeds Landing to Genoa	43,470.25	.230	.226	.022	.050	.528
Keokuk to Quincy	32,591.33	.365	.204	.028	.075	.672
Quincy to Clarksville	20,288.16	.299	.296	.028	.074	.697
Illinois River to Missouri River	41,510.14	.272	.279	.027	.079	.657
Genoa to Prairie du Chien	30,929.04			.048		.618
Dubuque to Clinton *a*	31,053.08			.063		.684
Rock Island to Muscatine	41,772.34			.046		.492
Hamburg to Cap au Gris	34,656.51			.055		.593
Cap au Gris to Illinois River *a*	42,849.47			.042		.520
Total	327,145.07					.591

a Includes work of 1895, in which year the contracts were let.

Hired labor work—Average cost of towing and putting in material.

1891	$0.233	1894	$0.214
1892	.295	1895	.197
1893	.237	1896	.255

General statement showing net expenditures from the commencement of improvement to July 1, 1897, under various appropriations.

St. Paul to Des Moines Rapids		$1,560,323.17
St. Paul to Des Moines Rapids (practical test of Adams Flume)		*22,176.83
St. Paul to Des Moines Rapids (harbor at Lake City)		15,000.00
Minneapolis to Des Moines Rapids		1,096,905.62
Des Moines Rapids to Illinois River		1,330,000.00
Ohio River to Minneapolis (applied to "Between mouth of Missouri River and Minneapolis")		3,248,630.16
Total net expenditures		7,273,035.78
Balances July 1, 1897:		
Minneapolis to Des Moines Rapids (harbor at Burlington)	$3,094.38	
Ohio River to Minneapolis	978,236.54	
		981,130.90
Total appropriated		8,254,166.68

Net expenditures on the various sections of the river between Minneapolis and the Missouri River from commencement of improvement to July 1, 1897 (Rock Island and Des Moines Rapids improvement not included).

Locality.	Distance.	Amount.	Per mile.
	Miles.		
St. Paul to Minneapolis	11	a $75,235.09	$6,839.55
St. Paul to Prescott	32	677,169.25	21,161.54
Prescott to Lake Pepin	29	237,597.24	8,193.00
Harbors in Lake Pepin	....	27,384.72	....
Foot of Lake Pepin to Alma	12	341,450.99	28,454.25
Alma to Winona Bridge	29	486,219.00	16,766.17
Winona Bridge to La Crosse Bridge	31	278,389.85	8,980.31
La Crosse Bridge to McGregor Bridge	72	515,815.38	7,164.93
McGregor Bridge to Dubuque Bridge	59	178,289.11	3,021.85
Dubuque Bridge to Clinton Bridge	67	245,264.90	3,660.67
Clinton Bridge to Rock Island Bridge	40	394,957.81	9,873.95
Rock Island Bridge to Keithsburg Bridge	58	157,221.07	2,710.71
Keithsburg Bridge to Des Moines Rapids	60	613,898.65	10,231.64
Keokuk Bridge to Quincy Bridge	40	445,448.06	11,136.20
Quincy Bridge to Clarksville	60	740,234.51	12,337.24
Clarksville to Cap au Gris	43	516,268.32	12,006.24
Cap au Gris to Illinois River	27	272,054.57	10,076.09
Illinois River to Missouri River	25	280,052.82	11,202.11
Flint Creek to Iowa River Levee	....	96,101.00	....
Warsaw to Quincy Levee	....	83,627.46	....
Sny Levee	....	67,257.68	....
Quincy Bay	....	b 59,481.36	....
Hamburg Bay	....	10,000.00	....
Quincy Harbor	....	5,097.43	....
Rock Island Harbor	....	5,000.00	....
East Dubuque Harbor	....	5,000.00	....
Surveys, gauges, and meter work	....	190,496.18	....
Snag and dredge boats and wrecking	....	59,661.11	....
Facilitating navigation through bridges	....	2,072.72	....
Practical test of Adams Flume	....	27,176.83	....
Plant at estimated value	....	179,112.72	....
Total	....	7,273,035.78	....

a Of this amount $16,121.63 was expended in construction of Lock and Dam No. 2.
b $25,000 additional expended at Quincy Bay under a special appropriation.

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* In addition to this amount Mr. Adams expended $13,000 appropriated by acts of August 2, 1882, and July 13, 1892.

Money statements.

MINNEAPOLIS TO DES MOINES RAPIDS.

July 1, 1897, balance unexpended and available belonging to harbor at Burlington, Iowa	$3,094.38

OHIO RIVER TO MINNEAPOLIS, APPLIED TO THAT PORTION OF THE RIVER BETWEEN THE MOUTH OF THE MISSOURI RIVER AND MINNEAPOLIS.

July 1, 1896, balance unexpended		$578,221.81
Amount appropriated by sundry civil act approved June 4, 1897		826,666.67
Received from nonpayments		95.62
		1,404,984.10
June 30, 1897, amount expended during fiscal year		426,947.58
July 1, 1897, balance unexpended		978,036.52
July 1, 1897, outstanding liabilities	$35,661.11	
July 1, 1897, amount covered by uncompleted contracts	3,401.34	
		39,062.45
July 1, 1897, balance available		938,974.07
Amount that can be profitably expended in fiscal year ending June 30, 1899		1,500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Abstract of appropriations.

St. Paul to Des Moines Rapids:	
By act approved—	
June 18, 1878	$250,000.00
March 3, 1879	100,000.00
June 14, 1880	150,000.00
March 3, 1881	200,000.00
By act passed August 2, 1882	250,000.00
By act approved—	
July 5, 1884 (general improvement)	250,000.00
July 5, 1884 (applied to harbor Lake City)	15,000.00
August 5, 1886	382,500.00
Minneapolis to Des Moines Rapids:	
By act of August 11, 1888	600,000.00
By act of September 19, 1890	500,000.00
Des Moines Rapids to Illinois River:	
By act approved—	
June 18, 1878	100,000.00
March 3, 1879	40,000.00
June 14, 1880	100,000.00
March 3, 1881	175,000.00
By act passed August 2, 1882	200,000.00
By act approved—	
July 5, 1884	200,000.00
August 5, 1886	150,000.00
By act of August 11, 1888	200,000.00
By act of September 19, 1890	165,000.00
Ohio River to Minneapolis, applied to between Missouri River and Minneapolis:	
By act approved—	
July 13, 1892	600,000.00
March 3, 1893 (sundry civil)	866,666.67
August 18, 1894 (sundry civil)	866,666.67
March 2, 1895 (sundry civil)	866,666.67
By act of June 3, 1896	200,000.00
By act of June 4, 1897 (sundry civil)	826,666.67
Total	8,254,166.68

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., August 29, 1896, at 11 a. m., for "dredging at East Dubuque and in Galena River, Illinois."

[There is available for dredging at East Dubuque, Ill., from appropriation of $475,000 made by the river and harbor act of June 3, 1896, for "improving Mississippi River from mouth of Ohio River to Minneapolis," under an allotment of $200,000 made by said act for "improving Mississippi River from St. Paul to mouth of Missouri River," and a specific allotment therefrom of $5,000, also made by said act "for the removal of the bar in the Mississippi River, on the east side thereof, opposite the city of Dubuque, in the State of Iowa," the project having been approved, as per Department letter of July 15, 1896.—File number 16088.

There is available for dredging in Galena River, Illinois, under section 4 of river and harbor act of July 5, 1884, for "operating and care of canals and other works of navigation," an allotment of $6,000, made available for dredging in Galena River by project and estimate for care and maintenance of Galena River improvement for fiscal year ending June 30, 1897, approved by Secretary of War July 24, 1896, as per Department letter of July 28, 1896.—File number inclosure 4 of 6907.]

No.	Name and address of bidder.	East Dubuque (dredging and removing 30,000 cubic yards).		Galena River (dredging and removing 30,000 cubic yards).	
		Per cubic yard.	Total.	Per cubic yard.	Total.
		Cents.		*Cents.*	
1	C. H. Appleton, St. Paul, Minn	*a* 15	$4,500	....	....
2	M. H. Moore, Dubuque, Iowa	20	6,000	*b* 20	$6,000
3	A. J. Whitney, Rock Island, Ill	15	4,500	*a* 19¾	5,925

a Recommended for acceptance; accepted, and written contract made.
b Five cents additional where the tow is more than 2 miles.

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., November 10, 1896, at 11 a. m., for "construction of dams and shore protections between Reeds Landing, Minnesota, and Trempealeau, Wis."

[This work is covered by an allotment of $50,000 made by project approved September 4, 1896 (file number 15869), for the application of $200,000 authorized by the river and harbor act of June 3, 1896, to be expended during the fiscal year ending June 30, 1897, for "improving Mississippi River between St Paul and the mouth of the Missouri River," under continuing contract.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		75,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Fetter & Crosby, La Crosse, Wis.	$0.97	$24,250	$0.17	$12,750	*a* $37,000
2	Jacob Richtman, Fountain City, Wis	1.00	25,000	.35	26,250	51,250
3	Albert Kirchner, Fountain City, Wis	.94	23,500	.19	14,250	37,750

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., November 10, 1896, at 11 a. m., for "construction of dams and shore protections between Dubuque and Clinton, Iowa.

[This work is covered by an allotment of $35,000 made by project approved September 4, 1896 (file number 15869), for the application of $200,000 authorized by the river and harbor act of June 3, 1896, to be expended during the fiscal year ending June 30, 1897, for "improving Mississippi River between St. Paul and the mouth of the Missouri River," under continuing contract.]

No.	Name and address of bidder.	30,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$0.90	$27,000	$0.17	$4,250	*a* $31,250
2	A. J. Whitney, Rock Island, Ill	.94	28,200	.20	5,000	33,200
3	Jacob Richtman, Fountain City, Wis	1.00	30,000	.50	12,500	42,500
4	Patterson Bros., Keokuk, Iowa	1.00	30,000	.20	5,000	35,000

a Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., November 10, 1896, at 11 a. m., for "construction of dams and shore protections between Rock Island, Ill., and Muscatine, Iowa."

[This work is covered by an allotment of $30,000 made by project approved September 4, 1896 (file number 15869), for the application of $200,000 authorized by the river and harbor act of June 3, 1896, to be expended during the fiscal year ending June 30, 1897, for "improving Mississippi River between St. Paul and the mouth of the Missouri River," under continuing contract.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$25,000	$0.19	$4,750	$29,750
2	A. J. Whitney, Rock Island, Ill	1.00	25,000	.20	5,000	30,000
3	Patterson Bros., Keokuk, Iowa	.84	21,000	.23	5,750	[a]26,750
4	James Short, St. Charles, Mo	1.05	26,250	.35	8,750	35,000
5	Jacob Richtman, Fountain City, Wis	1.10	27,500	.40	10,000	37,500

[a] Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., November 10, 1896, at 11 a. m., for "construction of dams and shore protections between Keithsburg, Ill., and Nashville, Iowa."

[This work is covered by an allotment of $35,000 made by project approved September 4, 1896 (file number 15869) for the application of $200,000 authorized by the river and harbor act of June 3, 1896, to be expended during the fiscal year ending June 30, 1897, for "improving Mississippi River between St. Paul and the mouth of the Missouri River," under continuing contract.]

No.	Name and address of bidder.	25,000 cubic yards rock in place.		25,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$25,000	$0.19	$4,750	[a]$29,750
2	A. J. Whitney, Rock Island, Ill	1.50	37,500	.30	7,500	45,000
3	Patterson Bros., Keokuk, Iowa	1.25	31,250	.25	6,250	37,500
4	James Short, St. Charles, Mo	.95	23,750	.32	8,000	31,750
5	Jacob Richtman, Fountain City, Wis	1.10	27,500	.40	10,000	37,500

[a] Recommended for acceptance; accepted, and written contract made.

Abstract of proposals received and opened by Lieut. Col. W. R. King, Corps of Engineers, at Rock Island, Ill., November 10, 1896, at 11 a. m., for "construction of dams and shore protections between Hamburg, Ill., and the mouth of the Illinois River."

[This work is covered by an allotment of $50,000 made by project approved September 4, 1896 (file No. 15869) for the application of $200,000 authorized by the river and harbor act of June 3, 1896, to be expended during the fiscal year ending June 30, 1897, for "improving Mississippi River between St. Paul and the mouth of the Missouri River," under continuing contract.]

No.	Name and address of bidder.	35,000 cubic yards rock in place.		55,000 cubic yards brush in place.		Grand total.
		Per cubic yard.	Total.	Per cubic yard.	Total.	
1	Albert Kirchner, Fountain City, Wis	$1.00	$35,000	$0.30	$16,500	[a]$51,500
2	Thompson & Gray, St. Louis, Mo	.80	28,000	.44	24,200	52,200
3	James Short, St. Charles, Mo	1.10	38,500	.40	22,000	60,500
4	Golike & Rust, Alton, Ill	1.04	36,400	.46	25,300	61,700
5	Jacob Richtman, Fountain City, Wis	1.00	35,000	.40	22,000	57,000

[a] Recommended for acceptance; accepted, and written contract made.

List of contracts in force July 1, 1897, for improvement work on Mississippi River between mouth of Missouri River and St. Paul.

Name and address of contractor.	Designation and location of work.	Date of approval.	Commencement of work.	Expiration of contract.
Fetter & Crosby, La Crosse, Wis.	Building dams and shore protection, Reeds Landing to Trempealeau.	Jan. 2, 1897	June 8, 1897	Dec. 31, 1897
Albert Kirchner, Fountain City, Wis.	Building dams and shore protection, Dubuque to Clinton.	.....do	Apr. 29, 1897	Do.
Patterson Bros	Building dams and shore protection, Rock Island to Muscatine.	.....do	June 7, 1897	Do.
Albert Kirchner, Fountain City, Wis.	Building dams and shore protection, Keithsburg to Nashville.	.....do	Not begun..	Do.
Do	Building dams and shore protection, Hamburg to mouth Illinois River.	.....do	.....do	Do.
John A. O'Keefe & Co., Omaha, Nebr.	Building levees, Flint Creek to Iowa River.	June 6, 1896	July 1, 1896	Sept. 30, 1897

Comparative cost of materials, 1896.

Locality of delivery.	Rock, per cubic yard.		Brush, per cubic yard.		Earthwork, per cubic yard, in place.
	In place.	On United States barges.	In place.	On United States barges.	
Redrock		$0.35			
Pinebend to Hastings				$0.1425	
Grey Cloud		.28			
Lake City (within 4 miles of)		.40			
Reeds Landing to Lake City		.333			
Reeds Landing to Genoa				.118	
Closing Dam No. 2 (sheet 18)	$1.00		$0.25		
Genoa to Prairie du Chien	1.00		.14		
Dubuque (bar opposite)					
Dubuque to Clinton	1.00		.14		
Galena River					
Albany (vicinity of)				.16	
Leclaire		.50			
Leclaire (vicinity of)		.45			
Rock Island to Muscatine	.70		.19		
Iowa River		*a*1.00		*a*.20	
Do		*a*1.37			
Flint Creek to Iowa River					$0.08
Do					.0818
Do					.0899
Do					.09
Do					.0995
Do					.1039
Do					.12
Do	*b*6.15				
Do	1.98				
Mouth of Iowa Slough		*a*1.30		*a*.25	
Burlington (4 miles below)		.56			
Bay Island and Lead Island				.20	
Ballingers		.43			
Keokuk		.44			
Keokuk (vicinity of)		.38			
Warsaw to Quincy Levee, Hunt and Lima Lake district					.0895
Do					.11
Do					.1245
Do					.125
Do					.14
Do					.15
Do					.16
Do					.18
Do					.195
Warsaw to Quincy Levee, Indian Grave district					.1095
Do					.1395
Do					.14
Do					.147

a On bank. *b* Rubblestone.

Comparative cost of materials, 1896—Continued.

Locality of delivery.	Rock, per cubic yard.		Brush, per cubic yard.		Earthwork per cubic yard, in place.
	In place.	On United States barges.	In place.	On United States barges.	
Warsaw to Quincy Levee, Indian Grave district					$0.15
Do					.155
Do					.1575
Do					.20
Do					.21
Warsaw to Quincy Levee, Bear Creek outlet	$1.70				
Warsaw to Quincy Levee, Bear Creek outlet (rubble masonry)	2.47				
Warsaw to Canton				$0.225	
Canton (vicinity of)				.25	
Canton to Lagrange		$0.49			
Lagrange				.25	
Quincy Bay	.50				
Quincy		.525			
Quincy to Hannibal				.185	
Do				.21	
Quincy to Saverton				.20	
Hannibal		.48			
Do		.49			
Do		.50			
Louisiana		.50			
Louisiana (vicinity of)		.44		.21	
Do				.205	
Hamburg to Cap au Gris	.94		.15		
Cap au Gris to mouth of Illinois River	.87		.10		
Grafton		.43			
Grafton to mouth of Missouri River				16	
Mouth of Missouri River and Missouri River				.19	

NOTE.—Dredging and removing sand and mud at Galena River, per cubic yard, 19¾ cents; at East Dubuque, per cubic yard, 15 cents.

REPORT OF MR. J. D. DUSHANE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., January 30, 1897.

COLONEL: I have the honor to submit the following report of operations under my direction for improving the Mississippi River between Minneapolis and Lake Pepin for the calendar year 1896:

MINNEAPOLIS TO ST. PAUL.

Lock and Dam No 2.—During the past year negotiations for flowage rights and for the purchase of land for lock site have been much retarded by owners demanding exorbitant prices and by an attempt of the Mississippi River Improvement and Manufacturing Company to establish the right, under a charter granted in 1857 by the Territory of Minnesota, to build a lock and dam for power purposes at Meeker Island, in opposition to the construction of Lock and Dam No. 2 by the Government. To the close of the calendar year about 75 per cent of the necessary flowage rights have been acquired by deeds of record, all at nominal consideration. By resolution of the board of park commissioners of Minneapolis, dated December 2, 1895, deeds were executed September 8, 1896, conveying to the United States land for part of the lock site and flowage rights along the entire length of the pool on the left bank of the river and to various lands on the right bank.

Under project dated June 22, 1896, test pits and jet borings were made to develop more fully the sand-rock substratum and to determine the possible advantage of a change of location for the lock site to land already acquired. For this work pile driver 74 was equipped with a Worthington pump, gas pipe in suitable sections and sizes, and hand drills. Two-inch gas pipe, supplied with a water jet and weighted with the pile-driver hammer or driven lightly, readily penetrated the sand and gravel bed of the river and the underlying sand rock to any desired depth. The hand drill was used within the 2-inch pipe to break a way through coarse gravel. Whenever a bowlder was encountered, the boring was abandoned and a new boring made near by. A water jet supplied through a three-fourths-inch gas pipe within the 2-inch pipe was used to clear the outer pipe of broken rock and to raise for inspection samples of the sand rock. More reliable information was obtained by the above method than was possible by the use of the ordinary form of well-boring machine previously used. The river bed at this point is composed of gravel and bowlders, in depth from 4 to 24 feet, overlying the soft sand rock.

Condemnation proceedings for acquiring part of the lock site were not begun, as it now seems possible that this land may be purchased for a reasonable price, and to that end negotiations were progressing favorably at the close of the year. It is hoped to secure all necessary lands and flowage rights and to begin the construction of the lock foundation and part of the lock walls during season of 1897.

ST. PAUL TO LAKE PEPIN.

The improvement of the river between St. Paul and Lake Pepin was continued under projects approved April 17, 1895, and August 22, 1896, by hired labor and use of Government plant.

Building dams.—In the vicinity of South St. Paul eleven wing dams, Nos. 45 to 55, inclusive (sheet 2),* were constructed. Dam 14 was extended 70 feet, and repairs were made to dams in this vicinity and to dams and shore protections at Daytons Bluff, Newport, and Robinsons Rocks. Dam 55 was built of brush and rock in the usual manner, with crest about 4 feet above low water of 1864. Dams 45 to 54, inclusive, are each composed of a sand base raised to about 2½ feet above low water and a course of brush and rock sufficiently thick to bring the dams to grade, at least 5 feet above low water. The sand for these bases, 16,233 cubic yards, was deposited in position for the dams by the hydraulic dredge *Geyser* while dredging for channel improvement in this vicinity. It was put in place at an expense of but a fraction of a cent per cubic yard, and made a substitute for an estimated quantity of 6,125 cubic yards of brush and rock.

It frequently happens that channel improvement by dredging becomes necessary in the vicinity of contemplated wing dams. The construction of such projected dams by the above method may be made simultaneous with the operation of the hydraulic dredge for channel improvement, and results in great saving of cost. Disregarding any benefits that may be derived by the removal of sand from the channel, the cost of constructing dams may be materially reduced by substituting sand for brush and rock in the base of the dams.

Materials were purchased in open market, under competition, delivered on United States barges, as follows: For brush, per cubic yard, 14½ cents; for riprap rock, per cubic yard, at Red Rock, 35 cents; at Robinsons Rocks, 28 cents. Launch *Emily* towed the material on United States barges to the works.

Owing to limited available funds for this work, the construction of dams was delayed until late in the season of low water, in order that the point at which improvements appeared most essential could best be selected. Work was begun September 15 and discontinued November 7.

Short stretches of shore protection should be built at Pigs Eye and below Quarantine Light, and works of improvement should be made in the vicinity of Hastings, Smiths Bar, Morgans Bar, Sturgeon Slough, and opposite Vermilion Slough.

Dredging.—Suction dredge No. 14, *Geyser*, attended by launch *Emily*, was put in commission April 1 and began operations April 9 at Island 15. About 15,000 cubic yards of sand was removed from the channel and deposited between Dams 15 and 45 (sheet 5), materially improving the channel crossing at this point. At Franklin Coulee a cut 180 feet in average width, 600 feet long, and at least 5 feet below low water of 1864 was made through the bar. The material removed from this cut was deposited to the right of the channel between dams, and is estimated at 18,000 cubic yards in place. A large percentage of the material removed—sawmill refuse—was carried away by the current, and is not included in above estimate.

Over 24,000 cubic yards of sand and gravel was removed from the gravel bar at Pigs Eye and deposited between dams to the left of the channel, the dredging extending from Dam 2 (sheet 1) downstream 1,400 feet, the width being 100 feet at each end and 200 feet over the shoalest part of the bar. The depth of cut was at least 5 feet below low water of 1864.

In the vicinity of South St. Paul the channel was dredged from Dam 20 to Dam 14 (sheet 2), a distance of 4,000 feet. The sand removed—27,700 cubic yards—was deposited to the right and left of the channel for use in construction of dams and in spoil banks. The dredge was then returned to Island 15 and made a cut extending upstream from the head of the island 600 feet, 100 feet wide, and at least 6 feet in depth below low water of 1864, and also made a cut 350 feet long, 100 feet wide, and at least 5 feet below low water, extending down the center of the channel from opposite Dam 15 (sheet 5). The material removed from the first cut—13,386 cubic yards—was deposited under Dam 34 and behind Island 15, and that from the second cut—7,396 cubic yards—was deposited under Dam 15 (sheet 5).

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*Sheet numbers are those of general maps, survey of 1878–79.

The dredge was operated with a double crew working two eight-hour shifts daily during the low-water period. Operations were discontinued for the season October 31.

During the coming season the dredge may be employed to great advantage in still further removing the gravel bar at Pigs Eye, maintaining the channel through drifting bars, and in building dams.

The entire Government fleet was put into winter quarters at Boulanger Slough, excepting launch *Emily*, dredge *Geyser*, and quarterboat 21, which, together with towboat *Fury*, were taken to South Stillwater for repairs, preparatory to next season's work. The dredge and launch were put on the boat ways.

List of works constructed and repaired and of materials used during the season of 1896 between St. Paul and Lake Pepin.

Designation.	Dimensions.		Material.		
	Length.	Height above low water 1864.	Sand.	Rock.	Brush.
Sheet 1:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Wing dam 31, raised	....	....	....	75.7	....
Wing dam 32, raised	....	....	....	82.1	....
Wing dam 33, raised	....	....	....	76.8	....
Wing dam 34, raised	....	....	....	80	....
Shore protection opposite Dam 34	....	....	....	88.5	....
Sheet 2:					
Wing dam 5, raised	....	....	....	76.4	60
Closing dam 12, raised	....	....	....	204	221.9
Wing dam 14, extended	70	....	....	212.4	383.5
Wing dam 16, end raised	....	....	....	40	65
Wing dam 19, end raised	....	....	....	40.5	72.3
Wing dam 21, end raised	....	....	....	78.2	....
Wing dam 22, end raised	....	....	....	62.9	....
Wing dam 27, end raised	....	....	....	78.2	....
Wing dam 29, end raised	....	....	....	82.1	....
Wing dam 30, end raised	....	....	....	24	....
Wing dam 31, end raised	....	....	....	20	....
Wing dam 32, end raised	....	....	....	20	....
Wing dam 40, end raised	....	....	....	76.7	....
Wing dam 45	220	5	1,736	205.7	158.4
Wing dam 46	120	5	1,700	190.6	260
Wing dam 47	230	5	1,600	230.4	448.1
Wing dam 48	220	5	1,575	261.5	224.9
Wing dam 49	278	5	1,690	228.6	246.9
Wing dam 50	282	5	2,670	238	506.4
Wing dam 51	100	5	782	124.2	140
Wing dam 52	210	5	1,853	211.8	165.5
Wing dam 53	290	5	1,453	188.1	491
Wing dam 54	225	5	1,674	158.2	300.5
Wing dam 55	700	4	....	544.1	840.3
Sheet 3:					
Wing dam 18, end raised	....	....	....	93.8	....
Wing dam 20, end raised	....	....	....	65.2	....
Wing dam 25, end raised	....	....	....	41.6	....
Wing dam 29, end raised	....	....	....	75	....
Wing dam 40, end raised	....	....	....	40	....
Wing dam 43, end raised	....	....	....	47.4	....
Shore protection opposite Dam 53	....	....	....	168.7	....
Sheet 4:					
Wing dam 18, raised	....	....	....	198.8	....
Total	....	....	16,233	4,623.7	4,584.7

Financial statement for work of building dams and shore protections between St. Paul and Lake Pepin for the calendar year 1896.

Amount expended in the field during the calendar year 1896 (from distribution sheets)	$6,661.42
Add quota of general superintendence and office expenses	349.15
Add for use and deterioration of plant	1,019.18
	8,029.75

Materials put in place:	
Rock ......cubic yards	4,623.7
Brush ......do	4,584.7
Total	9,208.4

Average cost per cubic yard:	
On barges	$0.228
For towing and putting in place	.495
For general superintendence and office expenses	.038
For plant	.111
	.872

Financial statement for dredging between St. Paul and Lake Pepin for the calendar year 1896.

Amount expended in the field during the calendar year 1896 (from distribution sheets)	$7,586.71
Add quota of general superintendence and office expenses	326.15
Add for use and deterioration of plant	1,208.59
Total	9,121.45
Material removed (sand) ... cubic yards	105,917
Average cost per cubic yard of sand removed	$0.086

Very respectfully, your obedient servant,

J. D. DuSHANE, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. W. A. THOMPSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
La Crosse, Wis., February 15, 1897.

COLONEL: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1896:

STOCKHOLM HARBOR, IN LAKE PEPIN.

Some slight repairs were made to the deck and sides of the pier by hired labor, and 373.5 cubic yards of rock was placed along the sides to strengthen the foundation.

The cost of the above work was $192.10.

LAKE CITY HARBOR, IN LAKE PEPIN.

All broken timbers and planks in the sloping side of the pier were removed and replaced with new timbers, and 397.3 cubic yards of rock was placed along the lower side of the pier to strengthen the foundation.

The cost of the above work was $272.36.

CONSTRUCTING A HARBOR IN LAKE PEPIN (KINGS COULEE).

The act of Congress passed June 3, 1896, appropriated $30,000 "for the purpose of constructing a harbor of refuge on the west shore of Lake Pepin, Mississippi River, at or near Kings Coulee, between Lake City and Reeds Landing, Minnesota."

The project for this work was approved July 24, 1896, and proposes the construction of a pier 770 feet in length, the foundation to be of gravel, the substructure of log cribs, and the superstructure of cribs of pine lumber with sloping sides and end. Width of pier on top, 10 feet; elevation, 12 feet above low water.

An examination of the proposed harbor site was made September 8 and 9, 1892. The pier is located on line No. 1 of this survey, the location being the one most desired by pilots and apparently the best. The line begins at a point on the bank between semaphore and telegraph pole at King's Coulee, about two-thirds of the distance above semaphore, and runs north on the line of the magnetic meridian. The natural depth of water on the line of the breakwater is about 33 feet at low water, with a range of about 16 feet.

Preparations for the commencement of this work were made immediately upon approval of the project. The work was performed by hired labor and use of Government plant. The material used (gravel and rock) was furnished as follows: All the gravel was supplied by United States dredge *Vulcan;* 640 cubic yards of rock was picked up along the bank by hired labor, and the balance used (963.1 cubic yards) was furnished, under public notice dated September 18, 1896, at 38.8 cents per cubic yard loaded on United States barges.

August 10, 1896, a dredging outfit was sent to Kings Coulee, and the construction of the shore embankment and gravel foundation for pier was commenced. As proposed, an embankment 70 feet long, raised to a height of 12 feet above low water, made of gravel with riprap protection 2 feet deep, was built at shore end. A large portion of the gravel used for the embankment was "cast" into place by the dredge and the balance was loaded on barges and from them wheeled in barrows to the top and sides of the embankment.

Taking the experience gained in the construction of the first 70 feet of embankment as a basis for estimating the cost of extending the embankment about 200 feet, and comparing such estimate with the estimated cost of an equal amount of crib work, it was found that the latter was the more expensive. The crib work is, furthermore, subject to constant decay, whereas a pier constructed entirely of gravel and rock, and possibly a course of brush, would be practically indestructible; and besides the apparent economy in the adoption of this method, it presents the additional feature of greater durability. Repairs to a pier built entirely of gravel and rock could be made much more readily than to crib work, on account of the close proximity of the materials needed for repairs in the former case and the difficulties attending the delivery of the timber, etc., that would be required in repairing crib work.

For the above reasons it was decided to deviate to some extent from the original project for this work and extend the embankment out into the lake some 200 feet beyond the 70 feet already built. During the season 250 feet of heavily riprapped gravel embankment, 10 feet wide on top and 36 feet wide at low-water line, were completed to a height of 12 feet above low water of 1864, and 50 feet more were built to a height of 8 feet above low water of 1864. The slopes above low water are 13 feet horizontal to 12 feet vertical, and the slopes of the foundation are the natural slopes of good, heavy gravel under water. The riprap at the bottom of the slopes is from 3½ to 4 feet thick, decreasing to 2 feet in thickness at the top. The top of the embankment is also covered with rock. The gravel was deposited under water by means of dumpboats, and for the part above water the gravel was wheeled onto the embankment from barges.

The accomplishment of this work required: 32,878.4 cubic yards of gravel, cast and dumped in place; 1,689 cubic yards of gravel, wheeled into place; 1,603.1 cubic yards of rock, wheeled into place. Time lost on account of storms and accidents, 170 hours.

The cost of the above work was $6,844.80.

Operations were suspended November 7, 1896, on account of cold weather. A part of the fleet was laid up for the winter in harbor at Lake City and the remainder was placed in winter quarters in Fountain City Bay.

The work thus far carried out has been very successful, and if that part of the pier which is completed has, as it is believed, sufficient strength to withstand the pressure of the ice and force of the storms during the coming spring, it is contemplated to modify such parts of the project as pertain to the substructure and superstructure of the pier to conform to the new method, and abandon the proposed crib work entirely. This cannot, however, be definitely determined before the ice breaks up in the spring, and it is not deemed advisable to make a change in the project until the advantages to be gained by such alteration are more fully established.

In addition to the expenses of the above work, the cost of the labor and part of the material required in the construction of two dump boats at Fountain City was paid from the money for harbor at Kings Coulee.

Amount expended for construction of two dump boats, $1,458.53.

Amount expended during calendar year 1896 (from distribution sheets), $8,303.33.

REEDS LANDING TO GENOA.

(*a*) *Construction of dams and shore protection.*—The improvement of this section of the river, 95 miles in length, by the construction and repair of dams and shore protection, was carried on under projects approved April 17, 1895, and August 22, 1896. Work during the season was performed by hired labor and use of Government plant, tow boat *Alert* and launch *Ada* being used for towing. Brush, loaded on United States barges, was purchased in open market under public notices dated April 28, September 20, and October 7, 1896, at 11.8 cents per cubic yard. The rock used was quarried and loaded on United States barges by hired labor and use of Government plant.

Owing to the long duration of the high-water period and the limited amount of appropriations, field operations were not commenced until July 14, 1896, when a part of the fleet quartered in Fountain City Bay was taken to the foot of Blacksmith Slough, where the construction of a piece of shore protection, 1,600 feet in length, on the Wisconsin shore below Wing Dam 35 (sheet 19), was commenced. This shore protection was completed August 10, 1896.

The work done at Tombstone or Mount Trempealeau Crossing, above La Moille, during season of 1894, proved of much benefit to that particular point in the river, but, owing to the lateness of the season and the greater necessity for completing the work commenced in the vicinity of Blacksmith Slough before the close of navigation, the work proposed for the improvement of La Moille Bar could not be carried out that year. As a result, the scour caused by the contraction of the river at Tombstone Crossing forced the sand downstream during the succeeding seasons until it reached a lodging place at La Moille Bar, the first wide point in the river below the works of improvement. Some trouble was experienced at this place during 1895, and when the water reached the ordinary summer stage in 1896, the bar became almost impassable for raftboats with their tows and was for a time the head of navigation for the larger packets. Several bad "breakups" occurred, and much time was lost by boats in their passage up and down the river. To remedy this trouble and permanently correct the direction of the channel at this crossing, a series of wing dams was constructed from the Minnesota shore and from west side of islands 79 and 80. This work, commenced August 11 and completed September 22, resulted in materially deepening the channel and confining the water to the 800-foot channel limit. No further trouble is anticipated in this locality. Two wing dams, 36 and 37 (sheet 19), aggregating 1,670 feet in length, the crown of the former 4½ to 6 feet, and the latter 4½ feet above low water of 1864, were built from Minnesota shore above head of Island 81. Lateral dam 38, 800 feet long, was built from the foot of Island 79, and Wing dam 39, 200 feet long, is from west side of same island, near the foot. Both dams are built to a height of 3½ feet above low water of 1864. A temporary wing dam, No. 40, 150 feet long, was built to a height of 3 feet above low water of 1864, from east side of Island 81, 540 feet below the head. Three wing dams, 41, 42, and 43, 600, 350, and 140 feet long, respectively, were built from west side of Island 80, below foot of Island 79. The crown of Dam 41 ranges in height from 8 feet at shore end, which is on a high sand bar, to 3 feet above low water of 1864 at outer end; that of Dam 42, from 12 feet at shore end, also on a high sand bar, to 4 feet at outer end. Dam 43 is built to a height of 3½ feet above low water of 1864.

The fleet was next moved to Island 83, below Trempealeau. The river here was very wide and correspondingly shoal, the obstructing bar, which had been in formation for years, having at last reached such dimensions as to stretch over the entire width of the river from shore to shore. The usual method for correcting and deepening the channel, by constructing wing dams from one or both sides of the river to decrease the width, was applied here with much success, the work being immediately followed by marked evidence of improvement in the condition of the channel. Wing dam 44 (sheet 19), an L shaped dam, was built from foot of Island 83; this dam extends laterally a distance of 240 feet, thence in an easterly direction at a right angle to the inner leg, a distance of 800 feet. Wing dam 45, built from east side of Island 84, 520 feet above foot of same, is 800 feet long. Wing dam 46 is an L-shaped dam from Wisconsin shore, the inner leg commencing at a point 2,200 feet above old Wing dam 7 and extending in a westerly direction 265 feet; and the outer leg continuing from this point in a lateral direction on a line toward end of Dam 7, a distance of 910 feet. These dams are built to a height of 3½ feet above low water of 1864. The work in this locality was completed October 20.

The survey made by me July 6, 1896, of the Mississippi River in the vicinity of the Chicago, Milwaukee, and St. Paul Railway bridge above La Crosse, developed the fact that the bar above the bridge, which had for years been gradually working down the river and increasing in size, would, if allowed to take its course, seriously obstruct the entrance to the draw span. As it was, the bar had already been forced down stream so far as to greatly increase the dangers attending navigation through the bridge, and to still further augment the difficulties the deep water showed a tendency to follow the Minnesota side of the river, which circumstance made immediate action necessary to obtain relief. To cut off the deep waterway and preserve the channel through the draw span, by directing the current to that side of the river, four wing dams, 41, 42, 43, and 44 (sheet 21), aggregating 1,218 feet in length, were built from the west shore of Island 101, a distance of 520, 1,100, 1,640, and 2,240 feet, respectively, above the shore pier of Chicago, Milwaukee and St. Paul Railway bridge. These dams were all built to a height of 3 feet above low water of 1864. This work, commenced October 20 and completed November 3, served to greatly facilitate the running of the draw span, and will no doubt prove efficient in maintaining the channel on the right hand side of the river.

November 3 the fleet was moved to Dam 12 (sheet 19), below Trempealeau. A break 90 feet long at shore end of this dam was repaired. Repairs to this dam were completed November 5, and the fleet moved to Island 71, above Winona. A break 120 feet long in Closing Dam 20 (sheet 18) was repaired. This work was completed November 9.

The shore protections built in and above Coon Slough during season of 1895 stood the severe test of the high water in the spring and summer of 1896, with but very little damage, and it was found when the water receded that the injuries sustained consisted chiefly in the misplacement of a few patches of rock. August 25 a small crew was put to work repairing these shore protections. Shore protections A, B, D, E, F, and G were given some slight repairs.

It was considered impracticable to build the proposed dams opposite Brownsville while the work for the improvement of the river at head of Coon Slough was in progress during 1895, the work and river being in such condition that the results could not be fully anticipated and relied upon. It was feared that the large body of sand immediately in front of town, which must of necessity be set in motion by the contraction of the river at this point, would move down to the head of Coon Slough and close the entrance, or at least seriously interfere with the passage into the slough. For this reason it was deemed advisable to postpone the work at Brownsville until such time as the current should have an opportunity to force the already large amount of sand in the slough farther down the river. This having been accomplished, and there being no reason to fear any serious results from a further deposit of sand in the slough, it was decided to carry out the projected work at Brownsville with as little delay as possible, the bar having in the meantime developed to such an extent as to make the work obligatory if it was desired to maintain the channel on the Minnesota side of the river. Accordingly, on September 9 a portion of the fleet remaining in Fountain City Bay was put in commission and the work of constructing the dams opposite Brownsville was commenced. Three wing dams, 54, 55, and 56 (sheet 22), aggregating 1,680 feet in length, were built from Wisconsin shore above old Wing Dam 53, at intervals of 815 feet, their height being 3 feet above low water of 1864. Old Wing Dam 34, above head of Crosby Slough, was repaired and raised to a height of 3½ feet above low water of 1864. Upon the completion of work in vicinity of Brownsville, October 27, the fleet was transferred to other parts of the work.

Operations were suspended for the season November 9, and the entire fleet placed in winter quarters in Fountain City Bay.

Works of improvement should be made at an early day in vicinity of Tee-pee-ota Point and Alma, below Minneiska, Mount Vernon, and Dresbach, and at Grand Crossing. The following series of dams should be extended: Right bank below Chimney Rock; opposite Fountain City; below Chicago, Burlington and Northern Railway Bridge at Winona; in vicinity of La Plume Island, and opposite Picayune Chute. Shore protections should be extended opposite Island 29, opposite Crats Island, at islands 55 and 58, Richmond Island, islands 93 and 96, Grand Island, Broken Arrow Island, islands 113 and 116, and in Coon Slough. Shore protection should be built below Dam 21 (sheet 15); above Buffalo Slough; opposite Island 55; at Island 63, and Winters Landing, and below Root River. Closing dam across Rollingstone Slough should be repaired and raised.

List of works constructed and repaired, and of materials used, during the season of 1894, between Reeds Landing and Genoa.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 18:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 20, repaired	....	3.5	210	1,419.5
Sheet 19:				
Wing dam 12, repaired	....	3.5	194.9	1,369.4
Wing dam 36	1,170	4.5-6	1,670.4	5,485.8
Wing dam 37	500	4.5	1,311.9	2,767.5
Wing dam 38	800	3.5	1,192.1	3,828.3
Wing dam 39	200	3.5	311.6	1,059.6
Wing dam 40	150	3	107.3	397.4
Wing dam 41	600	3-8	931.1	2,842.4
Wing dam 42	350	4-12	301.7	1,489.4
Wing dam 43	140	3.5	180.9	511.5
Wing dam 44	1,080	3.5	1,024.7	4,815.9
Wing dam 45	800	3.5	1,081.8	5,010.8
Wing dam 46	1,175	3.5	1,028.2	5,623.2
Shore protection below Dam 35	1,600	....	2,196.4	6,863.8
Sheet 21:				
Wing dam 41	348	3	393.9	1,921.9
Wing dam 42	410	3	588.4	3,262.3
Wing dam 43	300	3	396.5	1,878.9
Wing dam 44	160	3	392.7	2,289.4
Sheet 22:				
Wing dam 34, repaired	....	3.5	597.6	1,799.8
Wing dam 54	520	3	1,227.5	2,735.3
Wing dam 55	540	3	836.1	3,726.3
Wing dam 56	620	3	851.4	3,555.1
Sheet 23:				
Shore protection A (Coon Slough)	....	....	191.3	....
Shore protection B (Coon Slough)	....	....	185.1	....
Shore protection D (Coon Slough)	....	....	168.1	....
Shore protection E (Coon Slough)	....	....	181.9	....
Shore protection F (Coon Slough)	....	....	174.9	....
Shore protection G (Coon Slough)	....	....	248.6	....
Total	....	....	18,162.5	64,153

Financial statement for work of building dams and shore protection between Reeds Landing and Genoa, performed by hired labor, during season of 1896.

Amount expended in field during calendar year 1896 (from distribution sheets)		$38,706.76
Less repairs to Closing Dam 2 (sheet 18)	$483.32	
Less dredging in Coon Slough	229.54	
Less Lake City Pier	272.36	
Less Stockholm Pier	192.10	
		1,177.32
		37,529.44
Add quota of general superintendence and office expenses		1,835.49
Add for use and deterioration of plant		4,105.32
Total		43,470.25

Material put in works:

Rock	cubic yards	18,162.5
Brush	do	64,153.0
Total	do	82,315.5

Average cost per cubic yard:

On barges	$0.230
For towing and putting in place	.226
For general superintendence and office expenses	.022
For plant	.050
Average cost per cubic yard in place	.528

February 15, 1895, an agreement was entered into with H. F. Murr, of Fountain City, Wis., for the repair of Closing Dam No. 2 (sheet 18), at $1 per cubic yard for rock and 25 cents per cubic yard for brush, in place. This work had to be discontinued in 1895, before completion, on account of the weakness of the ice. Operations for the completion of the work were resumed February 10, 1896, and completed February 24, 1896. Three hundred and seventy-four and two-tenths cubic yards of rock and 236.5 cubic yards of brush—total, 610.7 cubic yards—were put in place during this time, at a cost, including $50 for inspection, of $483.32, and an average cost of $0.791 per cubic yard, in place.

Total amount of material put in place under agreement with H. F. Murr during 1895 and 1896: 523.4 cubic yards of rock and 567.6 cubic yards of brush—total, 1,091 cubic yards—at a cost of $715.30, and an average cost of $0.656 per cubic yard, in place.

(*b*) *Quarrying rock at Britts Landing, Wisconsin.*—Work was performed by hired labor and use of Government plant. Ingersoll-Sergeant steam drills were used for drilling in the quarry, and all the rock quarried was transferred from quarry to barges by means of the cable hoist.

Work of stripping east side of quarry hill below cable-hoist anchorage, by the use of teams, plow, and scrapers, was commenced May 5 and continued to May 19. During this time a section 390 feet long and 90 feet wide was stripped of stumps and soil to an average depth of 2 feet. The larger stumps were removed with dynamite, and the smaller growth was taken out with grubbing tackle and teams. The amount of stone thus made available was about 20,000 cubic yards, measured on barges, clear of all stripping. This method of stripping proved very satisfactory and economical.

During the month of June the work was chiefly preparatory, consisting in alterations to cable hoist, repairs to loading dock, etc. This work being of an experimental nature, was necessarily attended by numerous and expensive delays, all of which contributed largely to increase the cost of the work.

As the time before the commencement of field operations in this section of the river was limited, it was decided to operate the hoist without making all the changes desired. Accordingly, the work of quarrying rock and transferring same from quarry to barges by means of cable hoist was commenced July 23 and continued, with slight interruptions on account of accidents to cable-hoist machinery, until November 4, when all work was suspended on account of cold weather.

The ground on which the quarry is located was rented under lease dated August 1, 1895, and approved August 27, 1895, at an annual rental of $300.

Following are the amounts quarried per month and the average cost per cubic yard loaded on barges:

Month.	Number of cubic yards.	Average cost per cubic yard.
July	926.2	$2.036
August	4,679.8	.638
September	6,341.8	.510
October and November	6,214.7	.518
Total	18,162.5	.6261

Add to this all preliminary charges connected with work of quarrying rock, and the average cost of rock delivered on barges is raised to 69 cents per cubic yard.

(c) *Dredging in vicinity of Coon Slough, Winona, and Chimney Rock.*—During the winter and spring of 1896 the dredging fleet was thoroughly repaired and put in condition for the season's work. Towboat *Alert* left Fountain City on May 18 with dredge *Vulcan*, two dump boats, and one fuel barge in tow, arriving at Big Bend, in Coon Slough, on May 20. Dredge *Vulcan*, with the *Alert* as tender, commenced the work of widening the cut made at this point during 1895. Nine cuts, from 20 to 30 feet in width, aggregating 3,680 feet in length, and having a superficial area of about 78,000 square feet, were made on the sides of the original cut, thereby increasing the width of the channel from 275 feet to its present width of 400 feet, the least available depth being 4½ feet at low water of 1864; 37,029.2 cubic yards of material were dredged and dumped. This work was completed July 18, 1896, and the fleet moved to vicinity of Wilds Landing, above Winona. Towboat *Alert* was transferred to work of building dams, etc., between Reeds Landing and Genoa, and launch *Ada* was substituted for a tender to the dredge. The work above Winona consisted in the removal of a part of two wing dams and the shore protection at foot of Island 60, and the total removal of two other wing dams.

The project for the improvement of the river in vicinity of Wilds Landing contemplated maintaining the channel on the Wisconsin side of the river, and the dams removed—Nos. 30, 31, and 32 (sheet 17), which formed a part of the project—were built with that end in view, but they were not sufficient in number to bring about the desired result, and as a consequence the channel changed from the east to the west side of the river, following along the ends of the dams. The bar at this point increased in size from year to year, causing a corresponding decrease in the width of the channel, until, during the past season, there was hardly room for the passage of a half raft. The trouble could have been remedied by the completion of the work called for in the project, but as the funds available for general improvement were not sufficient for the work required here and at other points, it was decided to give relief by removing the dams and permitting the water to take its course down the west bank of the river. Wing Dams 31 and 32 (sheet 17) were entirely removed, and 200 feet of the east end of Dam 30 were dug out. One hundred and fifty feet of the east end of Wing Dam 17 (sheet 18) were removed for the same reason, viz, the bar crowding down on the end of the dam so close as to interfere with the passage. The current had cut in behind the shore protection at foot of Island 60, leaving the shore protection projecting into the river about 100 feet. This obstruction was removed. The work in vicinity of Wilds Landing was completed July 29, and the dredge was towed by the snag boat *General Barnard* to Island 55, below Chimney Rock. The shore protection on this island had become detached through the action of the current for a distance of 100 feet, causing an obstruction in the channel about 100 feet from shore. This obstruction was removed, and a strip 250 feet long and 35 feet wide was taken off the northeast corner of Island 55. Total amount of material dredged in vicinity of Wilds Landing and Chimney Rock was 4,647.7 cubic yards. Dredging operations in this section of the river were completed August 4, and the dredge was taken to Fountain City for repairs, preparatory to commencement of work on gravel foundation for pier or breakwater at Kings Coulee, Minn. The severe strain on the spuds while the dredge was working in Coon Slough during high water loosened the spud wells, and it was found necessary to calk them before sending the dredge into Lake Pepin. This work was done from August 5 to 8.

Total amount of material dredged during the season, 41,676.9 cubic yards.

The cost of this work was $5,087.04, of which amount $4,857.50 was paid from appropriation for "Operating snag and dredge boats on Upper Mississippi River."

GENOA TO PRAIRIE DU CHIEN.

Under project approved April 17, 1895, and allotment of $40,000, a contract, dated June 16, 1895, was entered into with Albert Kirchner, of Fountain City, Wis., for the construction and repair of rock and brush dams and shore protection at $1 per cubic yard for rock and 14 cents per cubic yard for brush, in place. No work was done during season of 1895, the contractor being engaged in other sections of the river.

Operations were commenced August 3, 1896, and completed October 17, 1896, during which time improvements were made above head of Crooked Slough, at McDonalds Slough, below Viola; Island 165, above Johnsonport, and Island 178, opposite Wyalusing. Three wing dams, two closing dams, and one piece of shore protection were constructed, as follows: Wing Dams 3, 4, and 5 (sheet 27) were built from the Wisconsin shore at intervals of 550 feet, the lowest dam of the series commencing at a point 50 feet above the first island above head of Crooked Slough. Closing Dams 1 and 2 (sheet 29) close the sloughs on either side of Island 165, the former being built between the Wisconsin shore and Island 165, and the latter between Islands 165 and 166. The above dams are built to a height of 4 feet above low water of 1864. The east shore of Island 178, opposite Wyalusing, was protected for a distance of 3,300 feet, extending downstream from a point 265 feet below the head of the island. Average width of the shore protection is 73 feet. Repairs were made as follows: Shore protection around head and down east side of Island 152, at head of Crooked Slough, was strengthened and repaired; Closing Dam 9 (sheet 28) was repaired and raised to a height of 3 feet above low water of 1864.

Mr. C. A. Stoddard was the inspector in local charge of the work.

List of works constructed and repaired and of materials used during season of 1896, under contract with Albert Kirchner, between Genoa and Prairie du Chien.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 27:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Wing dam 3	425	4	2,615.2	5,645.3
Wing dam 4	500	4	2,806.3	4,793.9
Wing dam 5	500	4	3,515.1	3,329.8
Sheet 28:				
Closing dam 9, repaired		3	1,972	3,126.5
Shore protection, Island 152, repaired			466.4	
Sheet 29:				
Closing dam 1	145	4	256	493
Closing dam 2	75	4	144.1	403.7
Sheet 31:				
Shore protection, Island 178	3,300		13,210	7,298
Total			24,985.1	25.090.2

Financial statement for work between Genoa and Prairie du Chien performed under contract with Albert Kirchner in 1896.

Amount paid contractor	$28,497.73
Cost of local inspection, etc	981.57
Add quota of general superintendence and office expenses	1,397.93
Add plant charge	51.81
Total	30,929.04
Material put in works:	
Rock ... cubic yards	24.985.1
Brush ... do	25,090.2
Total ... do	50,075.3
Average cost per cubic yard in place	0.618

SURVEY OF LA CROSSE HARBOR.

The river and harbor act of June 3, 1896, provides for a survey of "La Crosse Harbor, Wisconsin."

This survey, assigned by letter of the Chief of Engineers, dated September 5, 1896, was made in November, 1896, and a report, estimates, and map of same have been submitted. The cost of this survey was $100.

CARE, REPAIR, AND CONSTRUCTION OF PLANT.

During the year considerable repair and construction work was carried on at boat yard in Fountain City. Two dump boats, Nos. 11 and 12, were built. Repairs were made to towboat *Alert*, launches *Ada* and *Elsie*, dredge *Vulcan*, 1 dump boat and 11 barges. The cable hoist at Britts Landing was repaired and altered. The Trenton Iron Company was paid $4,130, due for the cable hoist. At such times as the plant was not in commission watchmen were employed in caring for same.

The cost of care, repair, and construction of plant was $9,185.68, of which amount $1,458.53 was paid from appropriation for harbor of refuge at Kings Coulee, Minn.

REEDS LANDING TO TREMPEALEAU.

Under project approved September 4, 1896, and allotment of $50,000 a contract, dated December 24, 1896, was intered into with Fetter & Crosby, of La Crosse, Wis., for the construction of dams and shore protection of rock and brush between Reeds Landing and Trempealeau, at 97 cents per cubic yard for rock and 17 cents per cubic yard for brush, in place. No work was done during 1896.

Respectfully submitted.

W. A. Thompson, *Assistant Engineer.*

Lieut. Col. W. R. King,
Corps of Engineers, U. S. A.

REPORT OF MR. J. C. M'ELHERNE, ASSISTANT ENGINEER.

United States Engineer Office,
Rock Island, Ill., January 23, 1897.

Colonel: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1896:

REMOVAL OF BAR AT EAST DUBUQUE.

Under project approved July 15, 1896, and appropriation of $5,000, made by river and harbor act of June 3, a contract, dated September 21, was entered into with C. H. Appleton for the removal of bar from the harbor at East Dubuque, at 15 cents per cubic yard.

Abreast of the city a large, high sand bar had formed, cutting off river communication with the shore in low and even in moderate stages of water. To give desired relief, dredging was carried on from September 19, 1896, to the completion of the contract on October 27. Opposite the warehouse and steamboat landing an area 650 feet wide at outer edge and 400 feet at the shore side was removed to a minimum depth of 4½ feet at low water, and the section was so shaped as to afford easy access for boats to those landing places.

A survey made and platted shows condition of the locality at the close of dredging operations.

The inspection work was performed successively by A. L. Richards and Louis Shaw, each of whom attended faithfully to his duties.

Financial statement for work in East Dubuque Harbor performed under contract with C. H. Appleton during season of 1896.

Amount paid contractor	$4,750.00
Add cost of local inspection, expenses, etc	250.00
Total	5,000.00
Amount of material removed ... cubic yards	31,666.7
Cost per cubic yard	$0.158

DUBUQUE TO CLINTON.

Under project approved April 17, 1895, and allotment of $40,000, a contract, dated June 16, 1895, was entered into with Albert Kirchner for the construction of brush and rock dams and shore protections, at 14 cents per cubic yard for brush and $1 per cubic yard for rock, in place.

At the close of 1895 the greater part of this contract remained unfinished. Work, therefore, was resumed on April 13, 1896, continued until May 9, and then suspended, owing to high water, until July 1, from which date favorable progress was made until completion of the contract on July 29.

In the vicinity of Savanna.—The work accomplished was the repairing of the old shore protection on High Willow Island, opposite Island 263 (sheet 41). This protection was for the most part rebuilt from a point around head of the island down to its foot, the average width being 35 feet.

At Elk River Slough.—Shore protections were put in on lower half of Island 28 (sheet 43), on Island 282, and immediately below it on Iowa shore, or Pomme de Terre Prairie, their respective widths being 47, 36, and 53 feet. A closing dam, No. 10, was also constructed between Islands Nos. 281 and 282, and a foundation was built for Dam 11 from Illinois shore over to Willow Bar, opposite foot of Island 282. The purpose of the former dam was to entirely close a little chute, and of the latter to partially restrain the draft of water from setting off so strongly behind the bar. The channel crossing at this point was thereby straightened, deepened, and greatly benefited.

Mr. C. A. Stoddard, as inspector, performed his duties in a very satisfactory manner.

List of works constructed and of material used during season of 1896 under contract with Albert Kirchner between Dubuque and Clinton.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 41:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Shore protection, opposite Island 263	1,550	....	2,324.2	1,324.0
Sheet 43:				
Closing dam 10	382	2.0	1,340.8	1,116.8
Closing dam 11, commenced	1,250	1.5	1,818.1	1,843.6
Shore protection, foot of Island 281	1,040	....	2,949.2	1,730.2
Shore protection on Island 282	1,550	....	2,844.6	1,820.1
Shore protection, Pomme de Terre Prairie	1,700	....	4,869.2	2,750.6
Total	....	....	16,146.1	40,584.8

Financial statement for work between Dubuque and Clinton performed under contract with Albert Kirchner during seasons of 1895 and 1896 (entire contract).

Amount paid contractor		$28,147.54
Cost of inspection, etc		1,671.89
Add quota of general superintendence and office expenses		1,165.72
Add for use and deterioration of plant		67.93
Total		31,053.08
Material put in works:		
Rock	cubic yards..	25,342.5
Brush	do....	20,036.0
Total	do....	45,378.5
Average cost per cubic yard in place		$0.684

IMPROVING ROCK ISLAND RAPIDS.

The portion of the fleet needed for immediate service having been thoroughly repaired, operations were resumed on March 25, 1896, the initial points selected being Duck Creek and Lower Chains.

Dams.—At Winnebago Chain the lower end of Trailing Dam 8½ was raised where the top had been worn away. To further straighten and control the swift current on Duck Creek Chain, work in and below that locality was continued. Trailing Dams 9½ and 11½ were slightly repaired, where injured, and the latter dam was finally extended downstream and connected with the outer end of Dam 18. Below the foot of the chain, at a distance of 2,100 feet, Wing Dam 17, begun last season, was built up narrow, but to an elevation of 6 feet below low water,—the height decided upon for the crests of all submerged dams to be built across and underneath the steamboat channel. Work thereon was then temporarily suspended, to both observe the effect of this dam in low stages, and, in the meantime, to advance the building of others in the vicinity. Wing Dam 18 was constructed out from the Iowa shore, at a point 1,000 feet below the chain. The body of this dam must be considered in four sections, of various lengths and heights, viz, the shore end, 510 feet in length; the next two in order, 400 and 290 feet, both submerged, and lastly the outer end, 130 feet; with elevations, respectively, of 2½ feet above, 6 feet below, 1 foot below, and 2 feet above low water. On the upstream side, excepting the 400-foot section, there was placed a heavy brush mat, 930 feet in length, to assist in preventing the wear incident to ice gorges and floods. The entire submerged section of Wing Dam 19, located midway between Dams 17 and 18, was built up fully to the proposed height. Wing Dam 16, located 6,000 feet below Duck Creek, was extended in submerged form across the channel, but the lateness of the season prevented its completion. The dams as far as built have greatly reduced the velocity of the current on the lower end of Duck Creek Chain, and have produced an additional depth of .64 of a foot of water there at extreme low water.

Rock excavation.—Two drill boats with double crews were employed, one throughout the greater part of the season, and a second one for a while in the spring, and afterwards, when additional funds became available.

Drill boat No. 6 blasted off the remainder of the abrupt shoulder on upper side of Lower Chain, between March 25 and July 8, but spent fourteen days of the time on the boatways undergoing repairs, the result of a serious accident caused by a premature blast. The reef there averaged 0.6 of a foot above grade, and the area worked over was 39,156 square feet. From July 9 to September 14, a large section of projecting shoulder below Cottonwood Chain and two dangerous points above entrance to Moline Pool were satisfactorily blown up, the average height above grade being 2½ feet, and area covered 30,320 square feet. The material in these localities was of an exceedingly hard nature, and in both places some difficulty was experienced in moving the boat owing to the shoalness of the water. From September 15 to October 5 several large and several small patches from 0.5 to 1.5 feet above grade were broken up between Moline and Lower Chains and dragged into surrounding deep water; and from October 6 to 10 two small patches above grade, met with on the upper shoulder of Lower Chain, were reblasted, the sum of the area worked over in both these localities being 4,832 square feet. The boat was then withdrawn from the Rapids to perform services elsewhere on the river.

Drill boat No. 103 worked temporarily from April 9 to 21 on abrupt shoulder at upper side of Lower Chain, and was then, owing to scarcity of funds, laid off until July 17. Between that date and October 20, including four days spent setting water gauges and ringbolts and in outlining reefs, the remainder of the large projecting shoulder below Cottonwood Chain was satisfactorily disrupted. This part of the ledge averaged 2½ feet above grade and covered an area of 31,232 square feet. On October 21 and 22 the channel immediately above the head of Moline Chain was carefully dragged over and some loose rock removed therefrom, and from October 23 to 27 the entire area recently blasted and dredged on upper shoulder of Lower Chain was thoroughly swept, and was found to be well down to grade. Work was then also suspended by this boat, which then went to assist the other one.

Dredging.—On April 6 dredge *Ajax*, with double crew, began removing débris from upper shoulder of Lower Chain, and having taken out by May 4 all material so far blasted there, moved up to the foot of Sycamore Chain. At that point the boat took up the broken rock from two patches at Illinois side of channel, which was blasted last year, finishing in three days. May 8 and 9 were put in at dredging scattering loose rock from the west side of channel through Winnebago Chain, and then, owing mostly to the existence of high water, the boat was laid off until August 25. On that date operations were resumed on lower end of large shoulder below Cottonwood Chain, but were discontinued on the following day to dig out the two dangerous medium sized rock patches situated above the entrance to Moline Pool. Those patches having been taken out by September 3, the upper shoulder of Lower Chain again received attention, and the remainder of the blasted rock was entirely removed therefrom by October 15. Between October 16 and November 27 the time was utilized at work on deep bank of débris on large shoulder below Cottonwood Chain, and about three-quarters of the area previously blasted was dredged over, leaving the bottom well below grade.

Removing loose rock and bowlders.—Barge No. 190 was newly fitted out with spuds, derrick, grapplings, etc., and in addition to assisting as spud boat at the dams, rendered valuable service wherever needed at obstructions. The areas dredged at foot of Sycamore Chain on Illinois side of channel were thoroughly examined, and such bowlders and broken rock as had been either missed or shoved over onto the reefs were, between August 21 and 26, carefully gathered up. From September 12 to 16 the top of the well-defined cut around upper shoulder of Lower Chain was also worked over and in like manner entirely freed from all loose rock. The material found was hoisted upon barges and placed in the dams.

Operations were discontinued for the season on November 27, and the fleet was then laid up in Moline Pool in charge of a watchman.

Much credit is due to Mr. J. B. Gordon, as overseer on the works, for the faithful performance of his duties.

Details of operations.

Towboat *Louise:*	
Hours working	598
Miles run, light	1,041
Miles run, towing	965
Miles run, total	2,006
Towboat *Mac:*	
Hours working	1,725
Miles run, light	1,697
Miles run, towing	2,923
Miles run, total	4,620
Towboat *Ruth:*	
Hours working	917
Miles run, light	1,181
Miles run, towing	1,733
Miles run, total	2,914
Drill boat No. 6:	
Hours working	2,514
Hours lost owing to rafts	1
Hours lost owing to accidents	43
Hours lost owing to storms	9
Holes drilled	3,136
Holes blasted	2,977
Linear feet of holes drilled	10,853
Range poles set in rock bottom	154
Ringbolts set out	4
Solid cubic yards of rock blasted	3,438
Cubic yards of broken rock raked into deep water	48
Pounds rackarock used	8,821
Drill boat No. 103:	
Hours working	1,532
Hours lost owing to rafts	3
Hours lost owing to accidents	21
Hours lost owing to storms	1
Holes drilled	1,957
Holes blasted	1,875
Linear feet of holes drilled	9,931
Range poles set out in rock bottom	79
Ringbolts set	12
Water gauges set	7
Solid cubic yards of rock blasted	2,987
Cubic yards of broken rock raked into deep water	30
Pounds rackarock used	5,597
Dredge *Ajax:*	
Hours working	1,638
Hours lost owing to rafts	1
Hours lost owing to accidents	104
Hours lost owing to storms	1
Solid cubic yards of rock dredged and removed	5,271
Cubic yards loose rock and bowlders dredged and removed	13,598
Derrick Barge No. 190:	
Hours working	80
Cubic yards bowlders and loose rock removed	100

Summary of total amounts of material.

Solid cubic yards of rock blasted	6,425
Solid cubic yards of rock dredged and removed	5,271
Cubic yards loose rock and bowlders dredged and removed	13,776

Cost of rock excavation, including charge for use and deterioration of plant.

Designation.	Rock excavated (solid cubic yards).	Total cost.	Average cost per solid cubic yard.
Shoulder below Cottonwood Chain, removed	3,463.0	....	....
Shoulder at head of Moline Pool, removed	313.2	....	....
Reach below Moline Chain, removed	58.0	....	....
Shoulder of Lower Chain, removed	1,436.7	....	....
Total	5,270.9	$23,297.38	$4.42
Shoulder below Cottonwood Chain, blasted only	1,154.1	3,902.22	3.381
Grand total	6,425	27,199.60	....

Cost of repairs to old piers, including charge for use and deterioration of plant.

Material.	Cubic yards.	Total cost.	Cost per cubic yard.
Riprap stone in place	300	$295.50	$0.985

List of dams and of material used in their construction and repair during season of 1896.

Designation.	Total length.	Riprap.	Brush.
Sheet 47:	*Feet.*	*Cub. yds.*	*Cub. yds.*
Trailing dam 8½, widened and raised	250	230.0	....
Trailing dam 9½, widened and raised	50	45.0	....
Trailing dam 11½, extended 335 feet	335	1,054.9	....
Wing dam 16, extended 500 feet	500	4,598.0	....
Wing dam 17, commenced	....	1,500.0	....
Wing dam 18	1,330	6,825.4	879.5
Wing dam 19, commenced	....	4,920.3	....
Total	....	18,673.6	879.5

Cost of dams, including charge for use and deterioration of plant.

Material.	Cubic yards.	Cost.	Cost per cubic yard.
Riprap rock in place	18,673.6	$18,393.50	$0.985

Financial statement for improvement of Rock Island Rapids for season of 1896.

Amount expended in field	$38,794.31
Add quota of general superintendence and office expenses	1,839.65
Add for use and deterioration of plant	5,254.64
Total	45,888.60
Distributed as follows:	
1. Rock excavated and removed	23,297.38
2. Rock broken up but not removed	3,902.22
3. Dams 8½, 9½, 11½, 16, 17, 18, and 19	18,392.50
4. Guide piers 11 and 21	295.50
Total	45,888.60

BUOYS ON ROCK ISLAND RAPIDS.

The buoys having been thoroughly repaired and painted, were reset, and the range posts at intervals readjusted, repainted, and renewed where necessary, between March 27 and April 30, 1896. As the season advanced 4 new buoys were established on submerged dams, viz: No. 22¾, at south side of channel on Dam 17, and No. 22¼ at north side and No. 22½ and 22 at south side of channel on Dam 18. No. 25, blasted out some time ago, has not yet been relocated. There were 13 buoys reset twice and 2 old buoy chains and 5 new ones put in. Belonging to the system there are now 31 buoys. From November 7 to 9 the range posts were again carefully examined and replaced where disturbed, and the buoys taken up and stored for the winter.

Cost of buoyage for the season was $375.

IMPROVING ROCK ISLAND HARBOR.

Under project approved August 22, 1896, and appropriation of $5,000 made by river and harbor act of June 3, 1896, operations were carried on in Rock Island Harbor by hired labor and use of Government plant.

The lower end, or rock section, in front of the levees, extending from West Seventeenth street up to Eighteenth street, was first well outlined and then worked upon by two drillboats with double crews, as herein stated, viz: Drillboat No. 6 from October 11 to November 27, and drillboat No. 103 from October 28 to November 23, 1896. The area worked over reached 100 feet riverward from the low-water line at shore; covered an area of 16,976 square feet, or nearly one-half of the original layout; averaged in height 3¼ feet above grade, and was excavated to a depth of 4 feet below low water. The material blasted has not been removed, but should receive attention at an early date.

Financial statement for improvement of harbor at Rock Island during the season of 1896.

Amount expended in field	$3,686.66
Add for use and deterioration of plant	457.14
Total	4,143.80
Amount of solid rock blasted .... cubic yards..	1,867.5
Average cost per cubic yard	$2.299

Very respectfully submitted.

J. C. McElherne,
United States Assistant Engineer.

ieut. Col. W. R. King,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

United States Engineer Office,
Rock Island, Ill., January 18, 1897.

Colonel: I have the honor to submit the following report of operations for improvement of the Mississippi River in the division in my local charge for the calendar year ending December 31, 1896:

ROCK ISLAND TO MUSCATINE.

Under project approved January 24, 1896, and allotment of $45,000 from appropriation of March 2, 1895, a contract, dated March 20, 1896, was entered into with Patterson Bros. for the construction of brush and rock dams and shore protections at 70 cents per cubic yard for rock and 19 cents per cubic yard for brush in place. Operations were begun May 9, 1896, and concluded November 4, on completion of the contract.

Vicinity of Credit Island and Rock River.—The main channel was divided near foot of Credit Island into two channels, the one to the north, although the deeper, being dangerous on account of rocks. It was decided, following the general project, to unite these channels in such a manner as to cause the main channel to flow along the south or Illinois side of the river, avoiding rocks, and also incidentally deepening and making practicable the entrance to the Illinois and Michigan Canal. Six wing dams from Credit Island were built, as also a closing dam from Credit Island to the Iowa shore. The effect of this work is apparent in the transfer of the now single channel to the Illinois side, but sufficiently good results as to depth and stability have not as yet been obtained, although it is expected another season will show great improvement in this direction also.

A survey of the locality was made subsequent to the completion of the work.

Vicinity of Buffalo.—A wing dam opposite Dodges, commenced in 1895, was completed, and three wings were built from the islands opposite the center of the town. These latter dams were built to concentrate the water in the main channel, and have had good effect. At Dodges the crossing, which was very bad in 1895, is now wide and deep.

Above Muscatine Bridge.—Three wing dams were built from the Iowa shore, the upper one being about a mile above the wagon bridge. These dams were built to deepen and straighten the channel and to keep it away from a large and dangerous reef of rocks. They have satisfactorily accomplished this purpose.

Mr. C. H. Sisson, the local inspector, gave excellent satisfaction in all branches of his work.

List of works constructed and of materials used during the season of 1896, under contract with Patterson Bros., between Rock Island and Muscatine.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cub. yds.*	*Cub. yds.*
Sheet 48:				
Closing dam 1	1,470	3	3,868.1	2,900.9
Wing dam 2	1,000	3	2,988.7	2,756.8
Wing dam 3	800	3	2,513.7	2,099.2
Wing dam 4	1,070	3	2,391.7	1,861.6
Wing dam 5	1,150	3	3,597.6	3,082.4
Dam 6, longitudinal portion and spur	1,744	3	4,431.3	5,163.9
Dam 7, longitudinal portion and spur	1,518	3	7,015.6	8,000.5
Dam 8, longitudinal	325	3	2,555	2,724.2
Sheet 49:				
Wing dam 5, completed	770	3	1,441.2	1,382.5
Wing dam 6	400	3	964.3	990.4
Wing dam 7	550	3	763.2	1,041.1
Wing dam 8	520	3	1,569.5	1,437.3
Sheet 51:				
Wing dam 7	1,430	3	3,608.6	3,593.7
Wing dam 8	1,000	3	2,673.7	2,822.9
Wing dam 9	730	3	2,124.4	2,529.1
Total	14,477	....	42,506.6	42,386

Financial statement for work between Rock Island and Muscatine performed under contract with Patterson Bros. during 1896.

Amount paid contractor	$37,807.95
Cost of local inspection, etc	1,582.25
Add quota of general superintendence and office expenses	2,307.30
Add for use and deterioration of plant	74.84
Total	41,772.34
Material put in work:	
Rock ... cubic yards	42,506.6
Brush ... do	42,386
Total ... do	84,892.6
Average cost per cubic yard in place	$0.492
Average cost per cubic yard for inspection	.019

The following table gives the length and elevation of the various dams built in this district in 1896, together with a statement of the estimated quantities of material and the actual quantities placed in the work:

Estimated and actual quantities of material—Rock Island to Muscatine, 1896.

Sheet and number.		Locality of dam.	Length.	Height above low water.	Estimated quantities.			Actual quantities.		
					Rock.	Brush.	Total.	Rock.	Brush.	Total.
			Feet.	*Feet.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
48	1	Credit Island	1,470	3	2,862.1	2,381.5	5,243.6	3,868.1	2,900.9	6,760
48	2	.....do	1,000	3	2,927	2,770.5	5,697.5	2,988.7	2,756.3	5,745
48	3	.....do	800	3	2,343.1	2,252	4,595.1	2,513.7	2,099.2	4,612.9
48	4	.....do	1,070	3	2,652	2,318.5	4,970.5	2,391.7	1,861.6	4,253.3
48	5	.....do	1,150	3	3,617.6	3,520.1	7,137.7	3,597.6	3,082.4	6,680
48	6	.....do	1,744	3	4,126.6	4,008.3	8,134.9	4,431.3	5,163.9	9,595.2
48	7	.....do	1,523	3	9,079.8	9,077.1	18,156.9	7,015.6	8,000.5	15,016.1
49	6	Opposite Buffalo, Iowa	400	3	922.6	882.5	1,805.1	964.3	990.4	1,954.7
49	7	.....do	550	3	992.5	936	1,928.5	763.2	1,041.1	1,804.3
49	8	.....do	520	3	1,428	1,378	2,806	1,569.5	1,437.3	3,006.8
51	7	Above Muscatine, Iowa	1,430	3	3,570.6	3,481.3	7,051.9	3,608.6	3,593.7	7,202.3
51	8	.....do	1,000	3	2,640.8	2,474.3	5,115.1	2,673.7	2,822.9	5,496.6
51	9	.....do	730	3	2,142	2,074.5	4,216.5	2,124.4	2,529.1	4,653.5
		Total	13,387	....	39,304.7	37,554.6	76,859.3	38,510.4	38,279.3	76,789.7

It will be noticed that the combined estimates of the thirteen dams, aggregating in length 13,387 feet, agree very closely with the total amounts of material actually used. Considerable discrepancies may be noticed in a few of the dams, caused partly by excessive scour under the apron mat and partly by a filling in of sand. In the former cases the actual quantities exceed the estimates and in the latter they are less.

I do not find any indication of brush shrinkage in the examples given.

The preliminary estimates were made from soundings taken along line of dam and just in advance of the laying of the apron mat, and the calculations from the regular office tables.

FLINT CREEK TO IOWA RIVER LEVEE.

With the exception of February, construction work was carried on throughout the year.

Under contract with M. H. King a small amount of embankment was built in January, but Mr. King not showing sufficient energy in the prosecution of his work, his contract was annulled on April 7, 1896. It being thought desirable to complete the work to end of mile-section 8 before high water came, under paragraph 49 of the specifications, agreements were made in March with several persons to do this work, amounting to 72,147.6 cubic yards, which was finished by the end of April.

After the annulment of the contract with M. H. King, a contract, dated May 28, 1896, was entered into with John A. O'Keefe & Co. to perform the work in mile-sections 9 to 18, inclusive, the same being the unfinished portion of the King contract. Owing to high water, no work was done on this contract until July, but since that time operations have been carried on vigorously. By the end of the year, under the O'Keefe contract, sections 10, 14, and 15 were completed and accepted; about one-half of the work in sections 9, 11, and 17 was done, and nearly all of sections 13, 16, and 18. The amount of earthwork performed under this contract was 354,476 cubic yards.

Under contract with Edward Callahan, dated April 7, 1896, sections 19, 20, 21, and 22 were completely finished and accepted, 179,359 cubic yards of embankment being put in place. Work under this contract was carried on vigorously.

The total amount of earthwork put in place under all contracts and agreements in 1896 was 604,230 cubic yards.

The new levee in sections 4 to 8, inclusive, was somewhat damaged by heavy rains, and repairs were made in July at a cost of $64.50. Grass seed was sown on about 12 miles of the levee during September, a mixture of timothy, blue grass, and red clover being used. The seed came up well, except on the sand fills, and is doing nicely. More seed will be sown in February.

For drainage purposes a line of 36-inch iron pipe, fitted with iron valves, was put in at Prairie Slough, at Iowa Slough, at Gates Lake, and at Cox Lake. Two lines of pipe are on hand for use at Running Slough, but are not as yet in place. There are now three 36-inch openings at Iowa Slough. Retaining walls were built around the pipe at Prairie Slough and Iowa Slough, and a paving of rock was laid in front of the wall and also around the pipe at the intakes. Similar walls are being built at Cox and Gates lakes.

During February, 1896, 600 linear feet of shore protection was put in place on the bank of the Iowa River for the preservation of the levee, and 377 cubic yards of rock and 337 cubic yards of brush were used. This shore protection, which was carried up the bank to a height of about 5 feet above low water, cost about $1.18 per linear foot.

The construction of 3,800 additional feet of shore protection on the Iowa River is now in progress, the work to be similar to that built in February.

The work pertaining to this levee has been in charge of Mr. E. E. Barrett, inspector, since its commencement, and his duties have been well performed.

Statement of expenditures, 1896.

Right of way (recording deeds)	$3.00
Drainage	2,310.28
Engineering and contingencies	8,783.04
Repair and maintenance	127.16
Iowa River shore protection	1,038.37
Earthwork	*60,827.97
Total	73,089.82
Average cost per cubic yard of earthwork, including engineering and contingencies	0.115
Average cost per cubic yard for engineering and contingencies	.014

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* Includes December estimate paid in January, 1897, and retained percentage.

Statement of expenditures from commencement of work to December 31, 1896.

Surveys for final location, etc	$5,083.37
Right of way	38.25
Drainage	3,050.26
Engineering and contingencies	11,402.63
Maintenance	127.16
Iowa River shore protection	1,038.37
Earthwork	68,776.56
Total	89,516.60
Average cost per cubic yard of earthwork, including engineering and contingencies	$0.122
Average cost per cubic yard for engineering and contingencies	.023

SURVEYS FOR LEVEES.

During September, October, and November, 1896, a small party in charge of Mr. E. E. Barrett, inspector, assisted by a portion of the crew of the U. S. snag boat *General Barnard*, made surveys with the view of estimating the cost of preventing overflow of the banks of the Mississippi River from Drurys Landing to New Boston, from Muscatine to the Iowa River, from Oquawka to Dallas, and from Skunk River to Fort Madison. Maps and reports on these surveys were rendered in December, 1896.

Very respectfully, your obedient servant,

C. W. Durham, *Assistant Engineer.*

Lieut. Col. W. R. King,
Corps of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

United States Engineer Office,
Keokuk, Iowa, January 14, 1897.

Colonel: I have the honor to submit the following report of improvement work performed under my direction between Keithsburg and Quincy for the calendar year 1896:

KEITHSBURG TO NASHVILLE.

Dams and shore protections.—Owing to the small amount of money available, but little work was done on this section of the river. In July a letter was received from a Mr. W. E. Blake, of Burlington, complaining that Dam 4 (sheet 58), in Rush Chute, had given way and was seriously damaging his land at the head of Rush Island. On examination it was found that the dam had broken at its junction with the bank, and a serious crevasse had occurred about 100 feet wide and had cut a semicircular hole out of the bank, about 2 acres in extent. On August 6 a small force of men and the canal launch *Lucia*, and such barges as could be picked up, together with a pile driver, began repairing it. The break was 100 feet wide and from 8 to 18 feet deep. Piles were driven 4 feet apart and the break filled with brush and rock; sheet piling was also driven at the abutment of the dam, about 4 feet long and extending into the bank about 25 feet, and the whole covered with riprap rock, which had to be carried some distance around in the gap made by the crevasse on the bank of the island. After completion of repairs to Dam 4 (sheet 58) some small repairs were made to Dam 1. Both of these dams were left in good condition. The fleet was returned to the canal September 11 to 15.

Examinations.—Between September 6 and 16 and October 12 and 31 the river became very low and the local packets experienced some difficulty in getting over several bars in this district, notably Benton Island, above Oquawka, foot of Shokokon, and foot of Dallas Chute. The worst of these was at Benton Island. On September 13, by your orders, I made a trip with the *Vixen* to see if there was any better channel than the one in use at several of these places. At Dallas Chute, where they reported 3 feet, we found a channel of 4½ feet and marked it with buoys; at the foot of Shokokon we found a channel of 4 feet and also marked that. At Benton Island, not being able to find any better channel, as the reef was a bold and continuous one, I put out anchors below the bar and at the extreme upper end of the reef. I made an attempt, by backing the boat up on the bar and, while her wheel was in motion, hauling her down with the capstan over the bar, to open a temporary channel. This work seems to have been partially successful. After working three or four hours in this manner we found the channel improved, over a very narrow space, however; and whereas at first the boat rubbed in crossing the bar in either direction, we could go over it without touching after we ceased work. This channel was marked with buoys, and on September 15 the *Vixen* was turned over to Mr. Carpenter for work between Keokuk and Quincy.

Under certain conditions, I am convinced that a larger boat, like the *Parke*, for instance, if properly handled, could do a great deal of good on such places as that on Benton Island last season. It is troublesome work and requires a very heavy anchor to hold the boat, and she should also have side anchors to keep her in position, as the rudders are not sufficient to hold her when so close to the bottom.

Rapids above Nashville.—No difficulty was experienced on the rapids, so far as I know, this season. There is one rock patch, however, a small one abreast of Pier No. 3, with but 3 feet large on it at extreme low water. Boats have struck on this at such times, but its removal is not urgent.

Rocks opposite Fort Madison.—On October 23 I made an effort to locate a rock said to exist in the channel opposite the landing at Fort Madison, and finally succeeded in discovering it. It is a backbone from 20 to 50 feet wide, extending parallel with the shore, and about 400 feet long. This ledge of rock, for it seems to be such, by some accident and by its extreme narrowness escaped the sounding pole in all the surveys we have made of that part of the river. I found but 3 feet of water at the upper end, and but 2 feet at the extreme highest point at the lower end, with from 3½ to 4 feet between. The best water is east of the rocks, and there is a sand bar just below the bridge which inclines boats to take a course that would bring them directly over the rocks.

A survey of these rocks was made in the month of November with the assistance of the crew of the steamer *General Barnard.* There is so much room for a boat on either side that I should think a couple of buoys properly placed to mark the upper and lower end of the ledge would be all the improvement needed at present. After a season or two the pilots will become familiar with the location of the buoys and will be able to miss the rocks even should the buoys not be there.

Financial statement for improvement work between Keithsburg and Nashville during season of 1896.

Amount expended in field during calendar year 1896	$2,906.81
Add quota of general superintendence and office expenses	137.86
Add plant charges	380.35
	3,425.02
Deduct cost of purchase and of driving 560 linear feet of piling	137.35
Total	3,287.67

Materials put in works:		
Rock	cubic yards	2,491.3
Brush	do	396.0
Total	do	2,887.3

Average cost per cubic yard:	
On barges	$0.514
For towing and putting in place	.445
For general superintendence and office expenses	.048
For plant charges	.132
Average cost per cubic yard in place	1.139

KEOKUK TO QUINCY.

Removing rocks.—April 16 to 30, the U. S. dredge *Phœnix* was put at work removing obstructions below and close to the Keokuk and Hamilton Bridge and just above the bridge. I quote the following from the report of Mr. Byron Layton, overseer, who had charge of the work:

"Several high points were removed along the line of boom connecting Lower Lock and the bridge. These were loose rock, probably carried in by the ice, and were a source of trouble in grounding the boom at a low stage of water. Two patches of loose rock and clay were removed below the bridge, one at the foot of the draw-rest pier and one about 200 feet below. Several other high points directly out from steamboat landing were gone over with dredge, but proved to be ledge rock. Total cubic yards removed, 667.7."

The cost of the above work was $522.56, exclusive of plant charge.

General remarks.—Work was commenced April 1 and abandoned November 13. On account of high water the entire fleet was laid up from May 14 to July 8, 1896. This work was in charge of Mr. John R. Carpenter, overseer, for operations of the plant building dams and shore protection, and Mr. Byron Layton, overseer, for operations of the dredge *Phœnix* and tender. During the low-water season, from September 6 to 16 and from October 12 to 31, the channel was in remarkably good condition considering the stage of water, and showed great improvement at all places where works have been executed in the last two or three years. The only serious trouble was at Cottonwood Island, where during the closing days of the season we made a change of channel from the right to the left bank of the river, and before the bar cut out boats often had a little trouble to get over; but as only one boat was running at the time, this change having been purposely postponed until most of the boats had laid up, no real damage to navigation ensued.

The navigation at close places was very greatly assisted by a few bouys we had placed as soon as the water got toward a low stage. At a critical point in the middle of a long crossing, a good buoy is of incalcuable benefit to the pilots. The pilots of the steamer *Gem City* told me that they would have had to lay up two months earlier if it were not for the buoys. In the night, with range lights on opposite sides of the river, widely separated, it is impossible for the pilots to handle their boats so closely as a narrow channel often requires. But a white buoy, illuminated by the search light universally carried by Mississippi River boats, enables them to proceed with perfect confidence and prevents a great deal of delay. I am quite sure that this system of buoying the channel, while one of the most inexpensive methods of improvement, can be made of very great value to navigation. The range lights on shore are of primary importance, but the buoys in close places are hardly subordinate in value, and with the means at our hands for placing them they cost absolutely nothing except for the construction of the buoys themselves.

I would suggest that in many places the public convenience would be better and more cheaply served by substituting a white signboard for the lighted beacon, supplemented with a buoy properly placed out on the reef. Other long and wide crossings are better provided for by a light on each shore. Possibly some arrangement could be made with the Light-House Board to furnish us with buoys to be kept in position by us and reported from time to time to the light-house inspector.

Rocks at Gregory.—Opposite the mouth of Fox River, at Gregory, there are several patches of rock with deep water between them, which in the present condition of the river the boats are obliged to approach very closely. In fact the only practical channel now lies between these patches of rock, and they should be removed at an early date. The *Barnard* placed a buoy on the upper patch early in the season, which was of very great value to navigation. This patch has about 2 feet of water on it at low water and the lower patch has about 3 feet, and I submit in a separate package a map showing the present condition of the river and the position of these rocks.

Building dams and shore protections.—I quote from the reports of Mr. Carpenter and Mr. Layton the following:

"The work was carried on by day labor and use of Government plant, steamers *Vixen* and *Ruth* and launches *Louise* and *Lucia* being employed at different intervals during the season in towing material. Dredge *Phœnix* was employed between November 5 and November 13 in dredging gravel for Dam 2 (sheet 66).

"On April 2 the fleet was taken to Quincy Bridge and work commenced. About 500 feet of shore protection was repaired. Fleet was then taken below railroad dike above Quincy Bridge, and 415 feet of shore protected to a 7-foot stage.

"On April 11 fleet moved up to Smoot Chute, and force began repairing break on west end of Dam 2 (sheet 66) and protecting Island 418; continued work here until May 12, when work was suspended until July 9 on account of high water. The break in west end of dam was repaired, and 1,650 feet of shore protected on Island 418. During the high water in June the bank at east end of Dam 2 (sheet 66) washed out for a distance of 125 feet. On resuming work on July 10 we began repairing break in east end. This dam was originally intended to be built to a 6-foot stage, and the piling was driven and cap put on at that height; but the plan was changed, the piling cut off, and cap lowered, and dam was finished to a 4-foot stage. The work on this dam was very expensive, as all the work had to be done above the dam, making it necessary to wheel all the rock over building barge. Work was completed on August 5.

"November 5, dredge *Phœnix* and tender *Louise* were transferred from work in Quincy Harbor to the work of repairing Smoot Chute dam; 1,221.6 cubic yards was placed here, part being dumped and part shoveled into angles of dam. The work was left incomplete, the cold weather compelling us to abandon it on November 11. The dredging fleet, comprising dredge *Phœnix*, four dumps, one quarter boat, and one coal flat, was towed from Canton to the canal by launch *Louise*, with the assistance of launch *Lucia* for five hours, on the 13th.

"Force was, on August 5, put at work protecting Island 419, raising Dams 9 and 10 (sheet 66), and protecting towhead below foot of Island 419. Dams 9 and 10 were built of gravel in 1895, and this year were raised to a 4-foot stage with brush and rock. Dam 9 is 625 feet long and Dam 10 is 1,075 feet long. Two thousand seven hundred and seventy-five feet of bank on Island 419 was protected to a 7-foot stage; towhead below foot of Island 419 was protected for a distance of 480 feet and carried to top of bank. Nine hundred and forty-four feet of bank was protected on Missouri side, opposite Hogback, and connecting with old protection at Lone Tree. This protection was carried to a 5-foot stage. Dam 4 (sheet 67) was built from sand bar to head of Island 422. It is 215 feet long and built to a 1-foot stage. Most of this dam was built on a dry bar. It was necessary to protect the head of Island 422 for a distance of 438 feet to a stage of 4 feet. Fleet was then moved down river and 2,573 feet of bank protected on Illinois shore, above old shore protection opposite Island 424, to a 6-foot stage. Dam 5 (sheet 67) was then started. This dam was built out from the upper end of Island 424 and is 1,250 feet long and built to a 3-foot stage. After laying the apron for the dam, owing to the scarcity of brush the work was discontinued here, and the fleet was moved on October 4 to Curtis Point, where 3,282 feet of bank was protected to a 7-foot stage. On October 21 the fleet was moved back to Island 424 and work resumed on Dam 5; completed same and began on Dam 6. This dam is located 2,000 feet below Dam 5 and is 1,350 feet long. It is to be built to a 3-foot stage and is now built up to about low water; owing to lateness of the season it was not finished. Nine hundred feet of old shore protection opposite Island 424 was repaired and raised to a 6-foot stage.

"During high water in June, barges were placed in Niota Chute and 742.8 cubic yards of rock were loaded by the United States, closing up the A. R. Ravenscroft agreement that had been outstanding since 1891.

"On November 13, having used up all the material on hand, work was suspended for the season, and fleet laid up in canal and force laid off.

"The accompanying tracings show location of work performed during the season."

List of works constructed and repaired and of material used during the season of 1896 between Keokuk and Quincy.

Designation.	Dimensions.		Material.	
	Length.	Height above low water 1864.	Rock.	Brush.
	Feet.	*Feet.*	*Cub. yds.*	*Cub. yds.*
Sheet 65: Shore protection, Curtis Point	3,282	7	3,575.5	2,893.5
Sheet 66:				
Dam 1, repaired	....	6	300.7	....
Dam 2, repaired	....	4	4,201.5	3,091.3
Dam 9, raised	....	4	1,016.4	1,296.7
Dam 10, raised	....	4	1,065.5	750.2
Shore protection on towhead, foot of Island 419	480	7	516.5	470.6
Shore protection, Island 419	2,775	7	2,492.7	1,687.8
Shore protection, Island 418	1,650	7	2,022.7	1,492.5
Sheet 67:				
Shore protection at Hogback	944	5	868.6	511.4
Shore protection opposite Island 424 on Illinois shore	2,573	6	2,346.0	2,104.6
Old shore protection opposite Island 424 on Illinois shore repaired and raised	....	6	359.5	....
Shore protection, head of Island 422	438	4	....	....
Dam 4	215	1	629.0	827.6
Dam 5	1,250	3	2,677.6	6,706.5
Dam 6 (not finished)	1,350	0	1,086.8	2,367.9
Sheet 68:				
Shore protection below railroad dike above Quincy Bridge	415	7	410.2	299.0
Shore protection above Quincy Bridge, Missouri side, repaired	....	....	404.6	....
Total	....	....	23,973.3	24,499.6

Financial statement for building and repairing dams and shore protections during season of 1896 between Keokuk and Quincy.

Amount expended in field during calendar year 1896 (from distribution sheets)		$28, 845. 25
Add quota of general superintendence and office expenses		1, 367. 86
Add plant charges		3, 986. 14
		34, 199. 25
Deduct cost of purchase, driving, and capping piling	$242. 18	
Deduct cost of dredging 1,889.3 cubic yards of rock and gravel.	1, 026. 08	
Deduct cost of plant charges for dredging	339. 66	
		1, 607. 92
Total		32, 591. 33

Materials put in works:

Rock	cubic yards..	23, 973. 3
Brush	do....	24, 499. 6
Total	do....	48, 472. 9

Cost per cubic yard:

On barge	$0. 365
For towing and putting in place	. 204
For general sugerintendence and office expenses	. 028
For plant charges	. 075
Average cost per cubic yard in place	. 672

ENLARGEMENT AND REPAIR OF LEVEES BETWEEN WARSAW AND QUINCY.

This work proceeded under contract with Casgrain & McDonald for the earthwork, and by day labor and purchase of material in open market for the revetment along the river front. The early part of the season was especially unfavorable for this kind of work. The continuous rainfall inundated the bottoms and made the handling of earthwork difficult and expensive or put a stop to it altogether. An extension of contract was granted to Casgrain & McDonald to November 30, and later another extension was granted to December 31. Owing to a quarrel between the partners and financial difficulties the firm of Casgrain & McDonald was placed in the hands of a receiver, and the work during the latter part of the season was carried on under his direction.

In the month of August, as it was evident that Casgrain & McDonald were not able to finish their contract, and at the written request of Mr. Casgrain, who was the managing superintendent, and under paragraph 51 of the specifications of the contract, bids were advertised for in the local papers at St. Louis, Quincy, Burlington, and Keokuk, calling for the construction of certain parts of the levee still unfinished, and which Mr. Casgrain himself stated he was unable to let, as the receiver had ordered him to pay no more than the contract price for any portion of the work under any circumstances. Bids were accepted from eleven different contractors or firms of contractors, and they mainly finished their work before the 30th of November. On October 27, it becoming evident that even under the second extension of contract Casgrain & McDonald would be unable to finish their work, a second series of bids were asked for and proposals were accepted for finishing twenty-four stations near the head of Quincy Bay. The month proved a remarkably mild one, with very little cold weather to interfere with the work, and in December the levee work was completed.

The amount of earthwork performed during the year was 367,952.3 cubic yards, of which 61,561.5 cubic yards was done by parties hired by the United States, and the remainder under contract with Casgrain & McDonald.

The total amount of earthwork on this levee in repairing and strengthening in 1895 and 1896, is as follows:

For Hunt and Lima Lake districts	cubic yards..	289, 418. 7
For Indian Grave district	do.....	345, 200. 1
Total	do.....	634. 618. 8

In the month of July a widespread storm with unusual rainfall caused considerable damage to the work. Eight inches of rain fell within a week, and on July 24 Bear Creek rose to an unprecedented height, causing seven breaks in the north levee of Bear Creek, inundating the Lima Lake district, and causing many thousands of dollars worth of damage to the standing crops. At the earnest solicitation of the farmers and the levee commissioners I authorized them to cut the levee just above the outlet of Bear Creek, and in a few days the impounded water escaped. The six drain pipes located at Big Slough proved entirely unable to carry off the rush of water, and had the levee not been cut much greater damage would have followed. The levee commissioners, by my advice and at the expense of the district, took advantage of the gap made where the levee was cut, to put in four more drain pipes of 48 inches diameter before the bank was repaired, so they are now provided with ten 48-inch drain pipes. In spite of this large provision, Lima Lake, located in the lower end of the district, and which measures 5 miles long and 2 miles wide, has not been dry this season, although it was cultivated last year. It acts as a valuable equilizer for absorbing the rainfall, and, in my opinion, much greater inundations will always follow any attempt to reclaim it for cultivation.

One of the principal causes of the breaks in the north levee was the fact that the whole area, 800 feet wide, between the north and south levees of Bear Creek, except the narrow channel (50 to 60 feet wide) occupied by the creek itself, was overgrown by a dense jungle of willows. The effect of this growth was to greatly impede the flow of water when the creek got out of its banks, and there has been such a deposit in this thicket from excessive overflows in the past that the ground between the levees is now from 4 to 6 feet higher than when the levees were originally built. Consequently the creek is suspended, as it were, above the adjoining land and renders the districts above and below Bear Creek subject to inundation at any time. At my suggestion the commissioners of the two districts united in clearing off these willows, and the beneficial effect of this clearing was felt later in saving at least one of these districts from another flood. After the close of our work the commissioners of the Lima Lake district got uneasy about the condition of their levee, and fearful that the height was still insufficient, after having been raised already by the United States, they made a contract for putting 2 feet additional on the levee, increasing its height that much from Stations 1,063 to 1,116+33, close to the bluff. In my opinion this was unnecessary, for I thought that removing the willows would provide waterway enough for Bear Creek, but subsequent events have proved that their precautions were well taken. The report to you, dated January 11, shows the flood lines and describes the inundation of the Indian Grave district caused by the great flood of January 3, 1897.

The launch *Lucia* and towboat *Ruth* were employed during the months of April, May, and June to revet a very much exposed portion of the levee opposite Canton, Mo. The levee is on the river bank at this point, and is exposed, without intervening timber or land, to the full force of the current and to the storm waves at high water, urged before the prevailing westerly winds. The stone was mostly purchased in open market, but a portion of it was picked up along the river bank in front of the levee, where the shore consisted of gravel and cobblestones. A strip of revetment about 10 feet wide was carried from Stations 748 to 829. In Hackley Chute, where the bank was caving close to the levee, a strip of brush and rock revetment 650 feet long was placed to arrest this caving, and from Stations 5 to 11, 1 mile below Warsaw, a similar point was protected for a length of about 600 feet. All this work was done to good advantage at high water, but in June the water began to fall and we were obliged to unload a pile of rock as close to the shore as possible and leave it to be placed when the water got sufficiently low. In October this rock was hauled a distance of 200 to 250 feet, and 500 feet of the levee between Stations 31 and 36 was revetted. There were placed in this revetment 2,826.8 cubic yards of rock, at a cost, including plant charges, of $1,066. All of this rock had to be loaded on wagons and hauled to place.

Statement of expenditures during calendar year 1896 for work on Warsaw to Quincy Levee.

Drainage	$35.62
Engineering and contingencies	5,052.41
Bank revetment	3,531.36
Repairs and maintenance	88.93
Earthwork	39,646.77
Total	48,355.09

Average cost per cubic yard of earthwork, including engineering and contingencies	$0.121
Average cost per cubic yard for engineering and contingencies	.014

Statement of expenditures from commencement of work to December 31, 1896.

Drainage	$82.92
Engineering and contingencies	13,088.59
Bank revetment	3,531.36
Repairs and maintenance	88.93
Earthwork	65,446.33
Total	82,238.13
Average cost per cubic yard of earthwork, including engineering and contingencies	$0.124
Average cost per cubic yard for engineering and contingencies	.021

Financial statement, Warsaw to Quincy Levee.

Amount expended, by vouchers, during the year ending December 31, 1896.	$48,780.94
Deduct liabilities, December 31, 1895	2,579.96
	46,200.98
Add liabilities, December 31, 1896	2,154.11
Expenditures, 1896	48,355.09
Expenditures, 1895	33,883.04
Total expenditures	82,238.13
Amount of appropriation	85,500.00
Amount expended	82,238.13
Amount available January 1, 1897	3,261.87

SURVEYS FOR LEVEES.

During September, October, and November, 1896, a small party in charge of Mr. R. Monroe, inspector, made surveys with the view of estimating the cost of preventing overflow of the banks of the Mississippi River from Alexandria to Canton and from Lagrange to Hannibal. Maps and reports on these surveys were rendered early in January, 1897.

DREDGING QUINCY BAY.

The balance of the appropriation of August 18, 1894, was used to continue the work in dredging Quincy Bay. The areas dredged by contract both above and below the bridge were very considerably enlarged, and, as will be seen by report of Mr. Byron Layton, overseer in charge of operations, at a less expense and at more than twice the speed at which the last contract was carried out. The following details are quoted from Mr. Layton's report:

"Work was carried on with Government plant, dredge *Phoenix* and towboat *Vixen* working double crew. Work began on July 20 and was finished on September 9. All dredging carried to 6 feet at low water. A basin 200 feet by 400 feet was dredged above line of north face of Empire sawmill. A mud bar formed across mouth of bay was removed. Two cuts were made along Quincy Levee from 200 feet above Broadway street to 100 feet below Diamond Jo warehouse. One cut was made along line of harbor piles from foot of bay up to Quincy marine ways. A field 1,200 feet long and 120 feet wide was dredged above the Chicago, Burlington, and Quincy stock yards. Cubic yards removed, 55,540.2; amount expended, $3,931.45; cost per cubic yard, exclusive of plant and office charges, 7 cents."

Financial statement for season of 1896, dredging in Quincy Bay.

Amount expended in field during calendar year 1896	$3,931.45
Add plant charges	1,309.91
Total	5,241.36
Cubic yards removed	55,540.2
Cost per cubic yard	$0.0944
Cost per cubic yard of Whitney's contract, including inspection, during season of 1895, the lowest price at which this work was ever done by contract on the Upper Mississippi River	$0.112

In February, 1896, some repairs were made to the pile bulkhead in the bay above the railway bridge. Several breaks had occurred in this bulkhead after heavy rains, and it was determined to reenforce the lower side of the bulkhead with riprap rock piled against it. This was done to a height of about 8 feet above low water, and a quantity of spalls was also placed along the inside of the east and west lines of bulkhead against the sheet piling; 1,118.5 cubic yards of rock was used in this work. Since the repairs were made the bulkhead has withstood a number of severe floods. The course of Whipple Creek has changed somewhat and there should be some protection of brush and rock put on the inside of the bulkhead near the north end.

Plant.—Some repair and construction work was performed at the dry dock of the Des Moines Rapids Canal, details of which are given in my report of the canal.

Very respectfully, your obedient servant,

M. MEIGS, *United States Civil Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. S. EDWARDS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 1, 1897.

COLONEL: I have the honor to submit the following report of operations for improving the Mississippi River in the division in my local charge for the calendar year ending December 31, 1896:

QUINCY BRIDGE TO CLARKSVILLE.

The work on this section was carried on by hired labor and use of Government plant, towboat *Coal Bluff* doing the towing. All supplies and material were purchased in open market under due competition.

The work consisted in repairing and building dams and shore protection. Closing Dam 1 (sheet 69), built in 1883, length 250 feet, had settled considerably since its construction, and as a result of this settling a gap 16 feet deep and 40 feet wide had formed. This gap was repaired and the dam raised to 8 feet above low water of 1864. Below Marion City 1,600 feet of shore protection was built to protect a badly caving bank. Head of Armstrong Island was also protected by 3,080 linear feet of revetment. A closing dam 2,100 feet long (Dam 14, sheet 74) was built between South Fritz Island and the Illinois shore. Two objects were gained by building this dam, namely, throwing more water into the legitimate channel in Hickory Chute and preventing an enormous amount of sand from traveling into channel below. Dam 15 (sheet 74) 708 feet long, a short distance below slough, was also built. This straightened the square crossing below Hickory Chute and gives the channel an easy and suitable curve. Slight repairs were made to shore protection on Missouri shore below Island 451. Dams 8 and 12 (sheet 70) were also repaired. No new material was used on latter dam, as the repairs consisted in leveling the dam with rock found below the crest.

The above constitutes all the work performed this season on "general improvement."

The total amount of material used was: Rock, cubic yards, 9,164; brush, 19,904.6 cubic yards; total, 29,068.6 cubic yards.

The shore protection below Marion City, as well as that on Armstrong Island, consists of an apron only, the same being 40 feet wide and carried up to between 3 and 5 feet above low water, according to the stage at time of working. The idea is to carry the revetment to top of bank at some future time, after the current at high water has sloped the top of the bank, thus saving the expense of grading. This method of building revetment, besides its cheapness, enables one to protect from three to four times as much bank during one season as if completed at once. As the caving in of banks is generally due to the washing away of sand strata at or about low water, the principal cause of cutting banks is thus removed. It will be found on this division that the high caving banks mostly consist of from 8 to 16 feet of a very hard substance of gum-like appearance and consistency, resting on a strata of sand. So long as this sand is not washing away no caving takes place, but so soon as the current, waves, or a receding high water removes this sand great blocks fall in. Both the closing dam and the wing dam built this season were low dams, with the crests at low water or a little above. I respectfully suggest that for some years to come all dams on this division be built not to exceed 1 foot above low water. The same advantage is herein gained as in building low shore protection, namely, two or three times as many dams can be built in one season. The cost per cubic yard is slightly increased by frequent movings of the plant, but the advantages far exceed this.

At Whitney Bar during the season of 1895 a great number of low dams were built. As I stated in my last annual report, it was predicted by river men that this place would be the head of navigation when low water set in, but this did not prove to be the case, as no boat ran aground. A fear was at that time entertained by them that the dams this year would cause the sand to move in such quantities as to obstruct navigation. Had the dams been high ones no doubt this might have happened, but with the low dams the scouring was so gentle that no high reefs were formed. It is now two years since a boat was aground at this place.

The channel from Quincy to Hamburg was in fair condition all season, and no boats were reported aground. The additional buoys placed this season for marking difficult crossings, in accordance with my suggestion, approved by you, have proved very useful to the pilots, and their success has been fully demonstrated by the hearty approval of river men and by the fact, as before stated, that no boats ran aground during the season, although during the latter part low-water mark was almost reached. I suggested in my last report that different colors be used to indicate to boats which side to take. This is unnecessary, as the buoys, with but few exceptions, are placed to "run under," and I think a buoy painted white and black would be best for all purposes. I would also suggest that all low dams be marked by a buoy at or near the end. The buoys should be made from 16 to 20 feet long, chained close to a weight of from 250 to 300 pounds.

List of works constructed and repaired and of materials used between Quincy Bridge and Clarksville, during season of 1896.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 69:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 1, repaired	250	8	1,220.1	1,064.4
Shore protection below Marion City (apron only)	1,600	4.5	1,201.4	2,743.4
Sheet 70:				
Shore protection, Island 438 (apron only)	3,080	5	3,061.5	5,245.8
Wing dam 8, repaired			230.6	1,207.5
Sheet 73: Shore protection, Missouri shore, below Island 451, repaired			287.9	285.2
Sheet 74:				
Closing dam 14	2,100	2	2,601.6	7,024.7
Wing dam 15	708	0	560.9	2,333.6
Total			9,164	19,904.6

Financial statement for work between Quincy Bridge and Clarksville, performed by hired labor during season of 1896.

Amount expended in field during calendar year 1896 (from distribution sheets)	$17,306.29
Add quota of general superintendence and office expenses	820.68
Add for use and deterioration of plant	2,156.19
Total	20,283.16

Material put in works:		
Rock	cubic yards	9,164.0
Brush	do	19,904.6
Total	do	29,068.6

Average cost per cubic yard:	
On barges	$0.299
For towing and putting in place	.296
For general superintendence and office expenses	.028
For plant	.074
Average cost per cubic yard in place	.697

REMOVING OBSTRUCTIONS BETWEEN QUINCY BRIDGE AND CLARKSVILLE.

On September 10 dredge *Phœnix* was received at Quincy, Ill., and taken to Dam 2 (sheet 70). This dam consists of a closing dam inside of Island 436 and a spur on the outer side, crest of spur being 2 to 10 feet below low water of 1864. The high points of this spur were very dangerous to navigation, especially in windy weather, when it was impossible to see the "break" of end of dam. This dam was leveled down to 6 feet at low water. The dredge was then moved to Submerged Dam 3 (sheet 73), below Cincinnati Landing. Some years ago, when this dam was partly dredged away, a portion 200 feet long, at Illinois shore, was not removed. This part, as well as a piece 75 feet long, 600 feet from shore, was very dangerous to boats at low water, several having hit it and had narrow escapes. Both the above portions were dredged off to 6 feet at low water.

On September 19 the dredge was returned to Quincy. The amount expended was $590.01, which was paid out of appropriation for operating snag and dredge boats

SNY ISLAND LEVEE.

The river and harbor act of June 3, 1896, contains an allotment of $50,000, or so much thereof as may be necessary, in the opinion of the Secretary of War, for the protection from erosion of the east bank of the Mississippi River along and in front of the Sny Island Levee, in the counties of Adams, Pike, and Calhoun, in the State of Illinois, for the maintenance of the channel of the river by revetment work or otherwise.

Your project to spend $15,000 during the fiscal year ending June 30, 1897, and reserve the remaining $35,000 for the three subsequent years was approved by the Chief of Engineers August 22, 1896.

The work contemplates protection of levee and river bank by revetment, built of rock and brush, at Kings and Harris islands, at Cincinnati Landing, above and below Louisiana, and at Coon Island, at which localities the shores are most exposed and liable to abrasion.

Owing to the late approval of the project and to the fact that the fleet was required at other points, the work was confined to protecting the river bank behind Kings Island, and the levee itself behind Harris Island, these being the two localities most exposed.

It would no doubt have been more economical to have postponed most of this work until next spring, when a higher stage of water would have enabled us to tow the material close to the work. With this object in view I had several interviews with the engineer in charge of levee district, the board of Sny Island Levee drainage district commissioners, and the people living in that vicinity. They all requested that the levee behind Harris Island should not be exposed to another high water without protection, and by reason of their urgent requests I decided to recommend that the work be done at once.

Behind Kings Island the river bank showed evidence of cutting, but the levee being some distance inland and of fairly hard soil, it was not thought necessary at present to protect anything but the bank itself. The revetment was carried to the top of the bank, 8.75 feet above low water, for a distance of 1,000 feet. Behind Harris Island the case was different, the levee there being of sand and the toe of its slope extending to the sloughs. It showed heavy cutting at several places, mostly due to wave action. The length of levee protected was 2,582 feet, the width being from 22 to 121 feet. The area covered was 20,499 square yards. A brush and rock apron was laid at toe of slope, and on the sandy portion of the levee a layer of straw 1 foot thick was placed and closely covered with rock. All the material had to be hauled by teams from the outer side of Harris Island, which necessitated first building a road 1,964 feet long to reach the levee. Eighty feet of water had to be spanned by a temporary bridge, built of trees covered with fascines of brush and resting on cribs.

On the bar between Harris Island and Sny Levee an experiment was made with a view of ascertaining the best way of planting willows. A space 400 by 300 feet was marked out and willows planted every 20 feet, in different ways, at a cost of about $6 per acre. It sometimes happens that a sand bar is so located that its presence is desirable in connection with further improvement work, and in such a case the cheapest way of keeping it in place is to start vegetation on it and afterwards protect it by revetment. A map of the planting will next year show which is the best method of planting the willows.

The Sny Island Levee work was begun September 5 and completed October 16. Amount of material used: Rock, 7,029.3 cubic yards; brush, 4,932.3 cubic yards; total, 11,961.6 cubic yards.

List of works constructed and of materials used on Sny Island Levee during season of 1896.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 71:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Shore protection behind Kings Island (443)	1,000	8.75	1,127.2	2,223.6
Shore protection behind Harris Island (444)	2,582	22.5	5,902.1	2,708.7
Total			7,029.3	4,932.3

Financial statement for work of protecting Sny Island Levee, performed by hired labor during season of 1896.

Amount expended in field during calendar year 1896 (from distribution sheets)	$10,179.37
Add for use and deterioration of plant	1,345.99
Total	11,525.36
Material put in works:	
Rock .... cubic yards	7,029.3
Brush .... do	4,932.3
Total .... do	11,961.6
Average cost per cubic yard:	
On barges	$0.369
For towing and putting in place	.482
For plant	.113
Average cost per cubic yard in place	.964

REMOVING SAND BAR AT QUINCY STEAMBOAT LANDING, QUINCY, ILL.

The river and harbor act of June 3, 1896, appropriated $10,000 for the above purpose. A survey was made July 3, 1896. Your project was forwarded to Chief of Engineers July 17 and was approved September 2.

The project calls for the cutting of a channel through the bar and building of two low dams on the bar above the city and one below on the Missouri side. Instead of making one cut through the bar two were made, as is shown in accompanying sketch. The two low dams were built and a "grundschwelle," 363 feet long, added as an extension to Dam 1 (sheet 68), and the upper side of the upper dredge cut protected by revetment. It is hoped that the low dams, which are of brush only, securely staked and sunk into the bar, will tend to hold the bar in place and that the "grundschwelle" will create a current strong enough to cut away the bar as far up as the revetment.

There was expended this fall the sum of $4,837.22, it being thought advisable to wait until next spring before doing anything more, so as to have a chance to study the effect of the improvements.

Dredge *Phœnix* worked here from September 19 to November 4; laboring force and fleet from October 17 to October 31. The amount of sand towed away and cast was 42,227 cubic yards.

The following amount of material was used in shore protection and dams: Rock, 940.2 cubic yards; brush, 3,823.8 cubic yards; total, 4,764 cubic yards.

I beg to state that I am aware of a great deal of criticism having been made at Quincy on this work, and would add the following facts: The lower point, in front of the city, and which it is desirable to remove, contains 373,000 cubic yards. If, as suggested, this should all be removed by dredging, the minimum cost would be $37,300, and the relief would be only temporary, as the bar is bound to move down. If the work done and contemplated proves to be a success, as I certainly believe it will, the cost will not exceed the $10,000 appropriated, and the relief will be permanent. A survey was made before the close of the work, and another survey of same grounds will be made next spring, which will very clearly show the effect of the work done.

In conclusion, I wish to extend my thanks to Mr. Ed. H. Jones, receiver of material, and Mr. C. C. Seymour, overseer, for their faithful and efficient services.

List of works constructed and of material used in removing bar at Quincy, Ill., season of 1896.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 68:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Dam 1, extended as a "grundschwelle"	363	—6 to —10	574.8	1,683.0
Dam 7, sunk into dry bar	851			818.6
Dam 8, sunk into dry bar	1,179			777.5
Shore protection, upper side, upper dredge cut	779	3.0	365.4	338.0
Planting willows on sand bar				206.7
Total			940.2	3,823.8

Financial statement for work of removing bar at Quincy, Ill., performed by hired labor during season of 1896.

Amount expended in field, dredging and building dams and shore protection, during calendar year 1896 (from distribution sheets)	$4,837.72
Add for use and deterioration of plant	574.74
Total	5,412.46

Divided as follows:

(1)

For building dams and shore protection	2,486.49
Add for use and deterioration of plant	421.80
Total (dams and shore protection)	2,908.29
Material put in works:	
Rock ... cubic yards	940.2
Brush ... do	3,823.8
Total	4,764.0
Average cost per cubic yard:	
On barges	$0.25
For towing and putting in place	.271
For plant	.089
Average cost per cubic yard in place	.610

(2)

For dredging	2,351.23
Add for use and deterioration of plant	152.94
Total	2,504.17
Material dredged (approximate):	
Removed and cast ... cubic yards	42,227.0
Average cost per cubic yard removed	$0.059

Very respectfully, your obedient servant,

S. EDWARDS, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF FIRST LIEUT. CHARLES KELLER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 19, 1897.

COLONEL: I have the honor to submit the following report of improvement work performed between Hamburg and the mouth of Missouri River during the calendar year ending December 31, 1896:

HAMBURG TO CAP AU GRIS.

Under an allotment of $50,000, and in accordance with project approved April 17, 1895, a contract was entered into with James Short, under date of June 11, 1895, for the construction of dams and shore protections between Hamburg and Cap au Gris. Prices to be paid were 94 cents per cubic yard for rock, and 15 cents per cubic yard for brush, in place.

No work was done under this contract during the season of 1895 on account of more urgent work being in progress in an adjoining section under contract with Mr. Short, which required use of all his available plant. In latter part of March, 1896, contractor moved a part of his outfit to Westport Island and commenced repairs on Dam 14 (sheet 79). During April the unfavorable condition of channel in vicinity of Reds Landing and Sterling Island determined the locality for present season's work. The channel near foot of Sterling Island has separated into two parts, one of which passed over toward Gileads Landing, on Illinois shore, and the other toward Sterling Landing, on Missouri shore. Both channels thus formed were crooked, narrow, and of insufficient depth. A bar was also forming above foot of Sterling Island, and channel made two crossings near middle of this island. The crossing below Reds Landing was also bad.

To remedy these conditions it was decided to construct three wing dams in vicinity of Gileads Landing, two more on Illinois shore opposite Island 490, and a closing dam between Islands 486 and 487; also to further protect head of Island 487, and extend shore protections of Islands 489, 490, and 491, where banks were cutting and depositing quantities of sand in channel. Those works were all completed during season extending from April to October. The dams, which were constructed first, have already shown a beneficial effect upon channel. The bar at foot of Island 487 has cut out, the dams in vicinity of Gileads Landing have stopped current going that way, have held sand above, formed bars below, and are moving down bars above foot of Sterling Island and opposite Sterling Landing.

Contractor James Short was unable to finish by June 30, 1896, the date of expiration of his contract, his work having been delayed by high water in May and June. He was granted an extension to October 15, 1896.

There were constructed under above contract, 6,495 linear feet of dams and 6,775 linear feet of shore protection, which, with the slight repairs made, required the use of 28,581 cubic yards of rock and 29,882 cubic yards of brush. The work was done under the efficient local inspection of Mr. J. A. Macfie, extract from whose reports are incorporated in the foregoing.

Further details as to length and height of works constructed are shown in the accompanying tables.

List of works constructed and repaired and of materials used during season of 1896, under contract with James Short, between Hamburg and Cap au Gris.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 79:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 14, repaired	....	....	98.8	52.5
Closing dam 17	475	4	1,485.9	2,455.5
Wing dam 18	680	2	1,723.1	1,347.1
Wing dam 19	950	2	2,434.1	2,297.9
Shore protection, Illinois shore, opposite Sterling Island	340	....	686.0	524.6
Shore protection, Island 487, extended	1,775	....	8,817.3	3,451.2
Shore protection, Island 489, extended	200	....	871.5	327.4
Shore protection, Island 490, completed	400	....	173.0	....
Shore protection, Island 491, extended	860	....	732.2	....
Shore protection, Island 491, completed	3,200	....	8,128.9	4,589.4
Sheet 80:				
Wing dam 4	1,530	2	3,397.8	5,497.0
Wing dam 5	1,400	2	8,512.6	5,838.8
Wing dam 6	1,460	2	2,520.3	3,501.2
Total	....	....	28,581.5	29,882.6

Financial statement for work between Hamburg and Cap au Gris, performed under contract with James Short, during season of 1896.

Amount paid contractor		$31,349.02
Cost of local inspection, etc		1,662.98
Add for general superintendence and office expenses		1,565.45
Add for use and deterioration of plant		79.06
Total		34,656.51
Material put in works:		
Rock	cubic yards..	28,581.5
Brush	do....	29,882.6
Total	do....	58,464.1
Average cost per cubic yard in place		$0.593
Average cost per cubic yard for inspection		.028

CAP AU GRIS TO ILLINOIS RIVER.

The work done in this section of river was a continuation of that of season of 1895, under contract with Mr. James Short, dated June 11, 1895, and in accordance with project approved April 17, 1895.

Contractor commenced season's operations on March 1, 1896, and continued without interruption until contract was completed on May 30, 1896. The following work was accomplished: Repairs were made to shore protection at Mound Landing and the existing work was extended 266 feet. Closing dam between Iowa Island and Bolters Island was thoroughly repaired and strengthened. Shore protection was built on Iowa Island for a length of 2,700 feet, and head of Island 526 was protected for a length of 1,000 feet. New wing dams were constructed as follows: Dam 18 (sheet 83), from Island 526, on channel side near head of island; Dams 19 and 21, from Masons Island, the former extending from center of island and the latter from near its head; Dam 20, extending from Missouri shore opposite Island 526; Dam 22, from Illinois shore below Squaw Island, and Dam 23, from Island 519, opposite foot of Hatchet Chute.

These works were all completed early in season and their beneficial effect on channel is already noticeable.

Mr. I. Mathewson was the inspector in local charge of the above work, and performed his duties faithfully and efficiently.

Further details as to length and height of works constructed are shown in accompanying tables.

List of works constructed and repaired and materials used during season of 1896, under contract with James Short, between Cap au Gris and mouth of Illinois River.

Designation.	Dimensions.		Material.	
	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 83:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 9, repaired	....	....	3,686.7	2,723.7
Wing dam 18	500	6.0	1,168.0	1,337.6
Wing dam 19	600	3.0	2,028.2	2,437.1
Wing dam 20	600	3.0	1,745.9	2,537.5
Wing dam 21	475	3.0	1,959.3	2,455.6
Wing dam 22	640	3.0	1,150.1	2,052.4
Dam 23	470	3.0	506.3	892.9
Shore protection, Mound Landing, repaired and extended	266	....	1,238.1	1,099.7
Shore protection, Iowa Island	2,700	....	6,911.2	7,031.2
Shore protection, Island 526	1,000	....	2,504.4	1,927.8
Total	....	....	22,898.2	24,495.5

Financial statement for work between Cap au Gris and mouth of Illinois River, performed under contract with James Short, during seasons of 1895 and 1896 (entire contract).

Amount paid contractor	$39,314.52
Cost of local inspection, etc	1,872.13
Add for general superintendence and office expenses	1,554.58
Add for use and deterioration of plant	108.24
Total	42,849.47
Material put in works:	
Rock .... cubic yards	40,350.0
Brush .... do	42,100.0
Total .... do	82,450.0
Average cost per cubic yard in place	$0.520
Average cost per cubic yard for inspection	.023

ILLINOIS RIVER TO MISSOURI RIVER.

Work in this section was carried on by hired labor and use of Government plant, the materials being secured by purchase in open market, in acordance with project approved April 17, 1895, under the unexpended balance of allotment of 1895 and an allotment of $30,000 from appropriation of June 3, 1896.

The work consisted in construction of spur and closing dams of rock and brush, for contracting and straightening channel, and in the protection of caving banks.

While there was apparent need of additional dams in vicinity of crossing at Hop Hollow, about midway between Alton and Piasa Island, it was thought advisable with the limited funds to confine the season's work to the stretch of river between Alton Bridge and the mouth of the Missouri River, as the channel in the vicinity of Maple Island, during periods of low water, has been difficult, owing to the formation of a bar at foot of the island. The channel above the island had separated into two parts, with the result that a considerable portion of the total discharge was taken from the main channel and had formed a crooked and indifferent channel between the island and Illinois shore. To increase the volume of water through the main channel and remove if possible the obstructing bars, dams were constructed as follows: A closing dam (33, sheet 84), extending from Illinois shore to the head of Maple Island, and two wing dams (34 and 35) from Illinois shore above Maple Island. Three wing dams (38, 39, and 40), with T-heads, were then constructed on Missouri shore opposite the bar at foot of Maple Island. A wing dam was commenced on the Illinois shore opposite the above series, but on account of low water its completion was postponed until next season. Shore protection was placed around the head of Maple Island, extending from closing dam for a length of 1,169 feet. Additional work for improvement of channel immediately below the Alton Bridge was done by the construction of two wing dams (36 and 37) from the Missouri shore. It is expected that these dams will throw the channel away from the Missouri shore and straighten its course below the bridge, thus affording a remedy for the present rather abrupt turn at entrance to the draw.

The shore protection on Mobile Island was repaired at its upper end and the work extended upstream a distance of 375 feet. The shore protection on Illinois shore below Wood River was extended downstream to about opposite mouth of Missouri River. About 3,500 feet of this extension was built up to a height of 5 feet above low water, and the mat only for an additional length of 1,350 feet was laid and rocked. The lateness of season, together with rise of water, prevented completion of this shore protection to full height proposed. The bank of the river at the site of this piece of shore protection being so hard as to render grading both difficult and expensive, it is proposed to leave the work of grading to the stream itself. The shore protection is therefore discontinued at the reference +5 until the action of the river may have given the upper portion of the bank a suitable slope.

Repairs were made to Closing Dam 15 at Portage Island. Considerable cutting out of bank had occurred at each end of dam, necessitating additional shore protections. The dam was also raised at island end to height of 8 feet above low water for a length of 175 feet. No further repairs appeared to be necessary in this section of river. The works thus far constructed are in good condition, and their favorable effect on channel is continuous.

A survey of river from Alton Bridge to below Maple Island was made during season, and maps of same were submitted.

For securing a safer winter harbor for Government plant used in this section it was decided to dredge out and enlarge an existing cut or bend in Illinois side of Portage Island. A dredge was secured at close of season and a portion of the excavation accomplished. Owing to lateness of season the harbor was not completed.

During the past season most of the dams built were in each case carried to the reference —2.0, and work then discontinued. The purpose of this modification of the usual practice of building a dam to full height in a single season is to avoid the sudden change of conditions brought about by this latter mode of construction. The river is now permitted to gradually change its former regimen. As far as could be determined, the results of this changed practice are wholly beneficial. In fact, the results have been such as to throw doubt upon the necessity of carrying the dams to a reference as high as +3.0. During the coming season this will be investigated and results daily reported.

Observations were made during the past season to ascertain whether the volume of material in the dams as determined by place measurement showed an increase upon or a diminution from the volumes as determined from barge measurements before construction. In a special report submitted to you it is shown that there is always a shrinkage, but this shinkage becomes relatively less as the proportion of brush increases. All doubt as to the propriety of using as large a proportion of brush as is consistent with permanency has therefore disappeared.

The present working season extended from July 18, 1896, to November 18, 1896. The towing was accomplished by use of U. S. steamer *J. G. Parke*. United States barges, quarter boats, office boats, etc., were also used in their respective places in carrying on the work.

Further details as to character and extent of work done are shown in maps submitted and in the following tables:

List of works constructed and repaired and of materials used during season of 1896 between Illinois River and Missouri River.

Designation.	Length.	Height above low water, 1864.	Rock.	Brush.
Sheet 84:	*Feet.*	*Feet.*	*Cub. yds.*	*Cub. yds.*
Closing dam 15, repaired			1,355.6	1,364.6
Closing dam 33	2,365	—2	3,889.6	4,159.5
Wing dam 34	3,150	—2	3,268.0	7,679.7
Wing dam 35	1,200	—2	767.3	1,701.8
Wing dam 36	640	—2	2,448.6	4,003.3
Wing dam 37	620	—2	1,284.1	3,585.4
Wing dam 38	280	3	536.1	1,283.8
Wing dam 39	350	3	932.6	1,903.9
Wing dam 40	470	3	577.5	1,413.5
Wing dam 41, commenced			475.5	914.9
Shore protection, Maple Island	1,169		1,913.3	2,286.4
Shore protection, Mobile Island, extended	375		995.4	894.7
Shore protection, Illinois shore below Wood River, extended	3,500		5,439.8	8,112.7
Total			23,883.4	39,304.2

Financial statement for work of constructing dams and shore protections between Illinois River and Missouri River, performed by hired labor during season of 1896.

Amount expended in field during calendar year 1896	$36,330.20
Less retained percentage (1895)	1,534.93
Net cost of field work	34,795.27
Add quota of general superintendence and office expenses	1,722.80
Add for use and deterioration of plant	4,992.07
Total	41,510.14
Material put in works:	
Rock ... cubic yards	23,883.4
Brush ... do	39,304.2
Total ... do	63,187.6
Average cost per cubic yard:	
On barges	$0.272
For towing and putting in place	.279
For general superintendence and office expenses	.027
For plant	.079
Average cost per cubic yard in place	.657

Very respectfully, your obedient servant,

CHARLES KELLER,
First Lieut., Corps of Engineers.

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER, ON PLANT.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 25, 1897.

COLONEL: I have the honor to present the following report on the floating stock or plant belonging to the improvement of the Mississippi River between the mouth of the Missouri River and Minneapolis, for the calendar year ending December 31, 1896:

In this report "good" is in fine condition, wanting slight repairs or none; "fair" requires extensive repairs, or such as are advisable; "bad" should be condemned or rebuilt. Pieces condemned are omitted.

The plant in question is as follows: 1 large towboat (*Coal Bluff*), fair; 1 medium-sized towboat (*Vixen*), good; 1 medium-sized towboat (*Fury*), fair; 1 medium-sized towboat (*Alert*), bad; 1 small towboat (*Ruth*), good; 1 small towboat (*Mac*), fair; 5 steam launches (*Lucia, Ada, Elsie, Iris, Louise*), good; 1 steam launch (*Emily*), fair; 1 small steam launch (*Florence*), good; 2 small naphtha launches (*Edith* and *Myra*), good; 1 small naphtha launch (*Dart*), fair; 2 dredges (*Phœnix* and *Vulcan*), good; 7 dumps, good; 1 steam-drill boat, good; 2 steam-drill boats, fair; 1 suction dredge, good; 1 pile driver, good; 2 pile drivers, fair; 1 pile driver, bad; 8 large quarter boats, good; 1 large quarter boat, fair; 1 large quarter boat, bad; 10 small quarter boats, good; 3 small quarter boats, fair; 3 small quarter boats, bad; 1 large office boat, good; 1 large office boat, fair; 13 small office boats, good; 1 small office boat, fair; 6 grasshoppers, good; 3 grasshoppers, fair; 1 grasshopper, bad; 1 derrick boat, fair; 2 store boats, bad; 1 boathouse, good; 4 building boats, good; 2 building boats, fair; 5 large model barges, fair; 1 large model barge, bad; 61 large barges, good; 30 large barges, fair; 1 large barge, bad; 5 small barges, good; 3 small barges, fair; 2 small barges, bad; and a large number of skiffs, loading boats, powder boats, and pontoons in good condition. To the snag-boat service belong the side-wheel steamer *General Barnard*, good, and stern-wheel steamer *J. G. Parke*, fair.

The Des Moines Rapids Canal has a small plant, consisting of 1 steam launch (*Stella*), good; 1 dredge (*Ajax*), fair; 3 dumps, good; 1 dump, bad; 1 large barge, good; 2 small barges, good; 1 small barge, fair; 1 small barge, bad.

During the year, under approved projects, 4 dumps were built and 1 dredge (*Phœnix*) rebuilt at the dry dock at Des Moines Rapids Canal; and at Fountain City two dumps were built.

Considerable repairs were made to snag boats *General Barnard* and *J. G. Parke;* to towboats *Alert* and *Mac;* to launches *Louise* and *Lucia;* to dredges *Vulcan* and *Ajax;* to 2 drill boats and to 1 suction dredge; 1 large barge was converted into a derrick boat. Nominal repairs were made to many pieces.

The construction and repair work at the dry dock was done under supervision of Mr. M. Meigs, United States civil engineer; that at Fountain City under supervision of Mr. W. A. Thompson, United States assistant engineer.

Very respectfully, your obedient servant,

C. W. DURHAM, *Assistant Engineer.*

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

REPORT OF MR. C. W. DURHAM, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., July 8, 1897.

COLONEL: I have the honor to present a brief preliminary report of operations between Missouri River and Minneapolis during the second half of the fiscal year ending June 30, 1897, as collated from reports of assistants in local charge. Full reports are made by calendar years.

St. Paul to Minneapolis.—In local charge of Assistant Engineer J. D. Du Shane. Construction of Lock and Dam No. 2 has been delayed by the difficulties attending the acquirement of land and flowage rights. These matters are now practically adjusted, the lock site has been chosen, plans for lock and dam have been drawn, and specifications for building the lock foundation are being prepared.

St. Paul to Lake Pepin.—In local charge of Assistant Engineer J. D. Du Shane. Construction work has not been resumed. The plant is receiving repairs so as to commence operations early in July.

Harbor at Kings Coulee, Lake Pepin.—In local charge of Assistant Engineer W. A. Thompson. Operations in construction of the pier were resumed May 17, from which time until end of fiscal year dredge *Vulcan* has been employed, dredging gravel for the pier; 24,826.8 cubic yards of gravel was dredged during May and June, and this material, together with 1,313.3 cubic yards of purchased rock, was placed in the pier. One hundred and fifty linear feet of the pier was built in May and June.

Reeds Landing to Trempealeau.—In local charge of Assistant Engineer W. A. Thompson. Under contract with Fetter & Crosby, approved January 2, 1897, and running to December 31, 1897, the construction of dams was carried on in vicinity of Crats Island from June 6 to close of fiscal year. Three wing dams, 34, 35, and 36 (sheet 14), from the left bank, were completed. Lateral Dam 37 was commenced.

There were placed in above work 3,011.5 cubic yards rock and 9,309.1 cubic yards brush.

Reeds Landing to Genoa.—In local charge of Assistant Engineer W. A. Thompson. Operations were commenced during last week of June. A small piece of shore protection on the head and east side of island at Big Bend, in Coon Slough, was built, in which were used 900.2 cubic yards rock and 2,743.5 cubic yards brush.

Dubuque to Clinton.—In local charge of Assistant Engineer J. C. McElherne. Under contract with Albert Kirchner, work was begun April 29 in vicinity of Bellevue. Eight wing dams, one closing dam, and 3,995 linear feet of shore protection were built at this locality. During the last week of June 920 linear feet of caving bank above Fulton was protected.

In above work were used 26,296 cubic yards rock and 30,011.6 cubic yards brush.

Rock Island Rapids.—In local charge of Assistant Engineer J. C. McElherne. Dredging of rock broken in 1896 was resumed May 27, near Dam 16. Drill boats 6 and 103 were at work during the second half of June at Lower Chain and Cottonwood Chain. An area of 4,032 square feet was covered by blasting, and the dredge removed 3,250 cubic yards rock, which was used in widening and repairing the south end of Dam 11.

Rock Island Harbor.—In local charge of Assistant Engineer J. C. McElherne. In March and April 375 solid cubic yards of rock was blasted by the drill boats, and this, together with the broken rock of 1896, amounting to 3,850 cubic yards, was removed from the city front and placed in dams 1 and 9, in vicinity of Credit Island.

Rock Island to Muscatine.—In local charge of Assistant Engineer C. W. Durham. Construction of dams under contract with Patterson Brothers was begun June 5 and continued to end of year. Three wings, aggregating 2,960 feet in length, were built from Illinois shore below Rock River, and a fourth, 480 feet long, from Iowa shore opposite, was begun.

There were put in place 6,277.1 cubic yards rock and 7,355.5 cubic yards brush.

Flint Creek to Iowa River.—In local charge of Assistant Engineer C. W. Durham. Levee construction was carried on during January, March, May, and June, under contract with John A. O'Keefe & Co., and 62,780 cubic yards of earthwork was performed, which nearly completes the upper 22 miles of the levee.

During January to June 2,704 linear feet of shore protection was constructed on right bank of Iowa River in sections 5 and 6. Two thousand two hundred and forty-two cubic yards rock and 1,063 cubic yards brush were put in this work.

In January retaining walls were built at Gates and Cox lakes, containing 18.12 cubic yards coursed rubble masonry.

In February 1,280 linear feet of revetment was built at Iowa Slough for the preservation of the levee embankment. There were used in the revetment 400 cubic yards rock and 552.6 cubic yards brush.

In March grass seed was sown on about 6 miles of the embankment.

Keithsburg to Nashville.—In local charge of Mr. M. Meigs, United States civil engineer. On June 14 improvement work by hired labor was commenced at foot of Dallas Chute. Seven cuts through the bar were made by dredge *Phœnix*, resulting in a channel 150 feet wide and the removal of 11,935 cubic yards sand. Dam 21, 1,600 feet long, was commenced.

Material put in place: Rock, 759.6 cubic yards; brush, 1,262.2 cubic yards.

Warsaw to Quincy Levee.—In local charge of Mr. M. Meigs, United States civil engineer. On January 3 a flood in Bear Creek broke the south levee in one place, inundating the Indian Grave district. The water gradually passed off through the pipes at the lower end.

On April 27, at a stage of 18 feet, the levee broke at Station 295 in the Hunt district. This break assumed large proportions, so that 24,000 cubic yards earthwork will be required for repairs. Under agreement, 1,300 cubic yards was put in place in June.

Quincy to Clarksville.—In local charge of Assistant Engineer S. Edwards. Improvement work by hired labor was resumed June 28 in the vicinity of North River. Dam 9, below North River, 400 feet long, was built, and Dam 10 was commenced.

Material used: Rock, 233.8 cubic yards; brush, 762.5 cubic yards.

Illinois River to Missouri River.—In local charge of First Lieut. Charles Keller, Corps of Engineers. Work in construction of dams and shore protection was resumed June 21, in vicinity of Hop Hollow. A trailing dam was commenced, and two wings opposite Hop Hollow were extended, one 550 feet, the other, 650 feet.

There were put in place 2,642.4 cubic yards rock and 3,592 cubic yards brush.

Very respectfully, your obedient servant,

C. W. Durham, *Assistant Engineer.*

Lieut. Col. W. R. King,
Corps of Engineers, U. S. A.

X 3.

OPERATION AND CARE OF DES MOINES RAPIDS CANAL AND DRY DOCK.

The Des Moines Rapids Canal was open to navigation 252 days, during which time there passed through it 760 steamboats and 272 barges, carrying 21,778 passengers, 40,365 tons of merchandise, and 54,345 bushels of grain. There also passed through the canal 101,649,675 feet, B. M., of lumber, 13,616,000 feet of logs, 28,866,520 shingles, and 28,834,228 laths.

The expenses of operating and care of the Des Moines Rapids Canal and Dry Dock, including dredging and repairs, have been during past year $36,180.04, including outstanding liabilities. Repairs were nominal, and the dredging amounted to 57,269.3 cubic yards, which makes the aggregate taken from the canal since June 30, 1878, 1,104,750.3 cubic yards.

The dry dock was in constant use. Dockage fees were collected from private parties to the amount of $71.25.

Details of canal and dry dock operations may be found in appended report of United States Civil Engineer, M. Meigs.

Money statement.

July 1, 1897, balance on hand	$1,163.67
June 30, 1897, amount drawn from Treasury during fiscal year, under indefinite appropriation	39,000.00
	40,163.67
June 30, 1897, amount expended during fiscal year	33,440.54
July 1, 1897, balance on hand	6,723.13
July 1, 1897, outstanding liabilities	2,739.50

Abstract of appropriations.

By act approved—	
April 30, 1878	$7,500.00
June 18, 1878 (allotment)	32,500.00
March 3, 1879	40,000.00
June 14, 1880	30,000.00
March 3, 1881, for fiscal year ending—	
June 30, 1882	45,000.00
June 30, 1883	75,000.00
June 30, 1884	47,000.00
June 30, 1885	40,500.00
June 30, 1886	43,000.00
June 30, 1887	44,000.00
June 30, 1888	42,000.00
June 30, 1889	39,000.00
June 30, 1890	43,837.97
June 30, 1891	43,995.80
June 30, 1892	44,000.00
June 30, 1893	58,000.00
June 30, 1894	56,652.49
June 30, 1895	41,000.00
June 30, 1896	36,500.00
June 30, 1897	39,000.00
Total	847,986.26

List of vessels docked in the dry dock at the Des Moines Rapids Canal during the fiscal year ending June 30, 1897.

Designation.	Date of entering dock.	Date of leaving dock.	Remarks.
	1896.	1896.	
Flat No. 93		July 6	
Flat No. 116		....do ...	
Flat No. 25	July 6	July 10	
Flat No. 78	....do ...	....do ...	
Flat No. 96	July 10	July 16	
Flat No. 44	....do ...	....do ...	
Flat No. 174	July 16	July 17	
Flat No. 186	July 17	July 22	
Flat No. 43	....do ...	July 29	
Steamer Vixen	July 18	July 18	
Flat No. 187	July 29	July 31	
Flat No. 195	Aug. 6	Aug. 12	
Flat No. G	....do ...	Aug. 18	
Dumpboat No. 9		Aug. 12	Built new.
Flat No. 185	Aug. 17	Aug. 19	
Steamer Quincy	Aug. 24	Aug. 25	Owned by private parties.
Quarterboat No. 121	Aug. 27	Aug. 29	
Pile driver No. 58	....do ...	....do ...	
Old hull of steamer Lucia	....do ...	Sept. 1	
Steamer Stella	Aug. 29	....do ...	
Steamer Louise	Sept. 8	Sept. 9	
Quarterboat No. 182	Sept. 17	Sept. 19	
Dumpboat No. 10		Sept. 30	Built new.
Steamer Lorna Doone	Oct. 2	Oct. 2	Owned by private parties.
Coal flat H	Oct. 15	Oct. 26	
Steamer Fox		....do ...	Built new.
Dredge Phoenix	Nov. 17	Nov. 20	
Steamer Pearl		Nov. 23	Do.
Pile driver No. 58	Nov. 20		Still in dock.
		1897.	
Barges 61, 62, 88, and 89	Nov. 23	May 11	
Barges 60 and 87	....do ...	June 1	
	1897.		
Building boat No. 64	May 19	May 24	
U. S. steamer Lily	May 24	....do ...	
Steamer Saturn	May 27	May 28	Owned by private parties.
Flat No. 93	June 1	June 5	
Office boat No. 12	....do ...	....do ...	
Office boat No. 85	....do ...	....do ...	
Office boat No. 41	June 5	June 8	
Office boat No. 51	....do ...	....do ...	
Flat No. 116	....do ...	June 19	
Barges 62 and 88	June 8	June 15	
Flat No. 43	June 19	June 23	
Flat No. 44	....do ...		Still in dock.
Steamer Coal Bluff	June 23	June 26	
Steamer Lucia	June 26	June 28	
Grasshopper No. 141	....do ...		Do.
Coal flat H	....do ...		Do.
Guard Lock Boom	June 28		Do.

Expenditures for operating and care of Des Moines Rapids Canal for fiscal year ending June 30, 1897.

Month.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Current repairs.	Total.
1896.								
July	$375.00	$14.45	$19.50	$408.95	$1,595.00	$88.44	$186.10	$1,869.54
August	375.00	5.70	6.00	386.70	1,595.00	4.10	174.90	1,774.00
September	375.00	100.95	18.00	493.95	1,595.00	171.60	299.84	2,066.44
October	375.00			375.00	1,595.00	204.98	393.11	2,193.09
November	375.00			375.00	1,595.00	95.55	690.38	2,380.93
December	500.00		18.00	518.00	1,432.85	6.82	1,383.57	2,823.24
1897.								
January	500.00	8.40	2.00	510.40	995.66	42.80	331.29	1,369.75
February	500.00	4.30		504.30	1,170.00	55.85	241.34	1,467.19
March	500.00		20.48	520.48	1,300.83	55.98	299.31	1,656.12
April	800.00	22.13		822.13	1,970.00	14.30	185.89	2,170.19
May	375.00			375.00	1,970.00	66.78	7.29	2,044.07
June		1.90		1.90		304.25	341.55	645.80
Total	5,050.00	157.83	83.98	5,291.81	16,814.34	1,111.45	4,534.57	22,460.36

Expenditures for operating and care of Des Moines Rapids Canal, etc.—Continued.

Month.	Dredging canal.				Grand total.
	Labor.	Supplies.	Current repairs.	Total.	
1896.					
July	$1,005.66	$407.03	$105.70	$1,518.39	$3,796.88
August	40.00	....	....	40.00	2,200.70
September	....	....	....	....	2,560.39
October	....	....	13.40	13.40	2,581.49
November	....	58.50	....	58.50	2,814.43
December	....	....	....	....	3,341.24
1897.					
January	....	....	....	....	1,880.15
February	....	....	....	....	1,971.49
March	....	40.33	....	40.33	2,216.93
April	1,146.36	217.27	195.58	1,559.21	4,551.53
May	1,416.00	107.80	17.84	1,541.64	3,960.71
June	108.59	561.32	246.99	916.90	1,504.60
Total	3,716.61	1,392.25	579.51	5,688.37	33,440.54

Comparative expenditures for operating and care of Des Moines Rapids Canal for the fiscal years 1890–1897.

Year.	Office and administration.				Canal and locks.			
	Salaries.	Supplies.	Miscellaneous.	Total.	Labor.	Supplies.	Repairs.	Total.
1890	$4,425.00	$120.84	$238.03	$4,783.87	$18,245.07	$2,376.55	$7,848.88	$28,470.50
1891	5,175.00	162.76	113.38	5,451.14	18,785.73	2,725.27	11,863.31	33,374.31
1892	4,495.00	156.04	210.75	4,861.79	18,099.98	1,612.98	5,012.20	24,725.16
1893	5,720.00	137.13	138.73	5,995.86	17,464.67	2,162.64	6,822.35	26,449.66
1894	5,135.00	121.71	711.56	5,968.27	19,585.65	1,707.04	12,974.85	34,267.54
1895	5,083.00	156.38	314.92	5,564.63	19,264.68	2,004.19	7,712.16	28,981.03
1896	5,187.50	92.10	323.44	5,603.04	19,137.31	1,507.77	6,423.68	27,068.76
1897	5,050.00	157.83	83.98	5,291.81	16,814.34	1,111.45	4,534.57	22,460.36

Year.	Dredging canal.				Grand total.
	Labor.	Supplies.	Repairs.	Total.	
1890	$3,196.58	$1,260.78	$6,284.07	$10,741.43	$43,995.80
1891	3,563.51	1,906.63	702.61	6,172.75	44,998.20
1892	11,333.23	6,370.52	4,259.47	21,963.22	51,550.17
1893	8,712.77	4,481.53	5,464.30	18,658.60	51,104.12
1894	6,719.81	2,227.41	7,716.02	16,663.24	56,899.05
1895	496.00	103.63	2,746.74	3,346.41	37,882.07
1896	3,056.94	1,385.42	441.05	4,883.41	37,555.21
1897	3,716.61	1,392.25	579.51	5,688.37	33,440.54

Traffic statement of the Des Moines Rapids Canal for the fiscal year ending June 30, 1897.

Month.	Boats up.	Boats down.	Barges up and down.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Shingles.	Laths.	Lockage at one lock.
1896.					*Tons.*	*Bu.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
July	67	58	36	4,643	5,924	1,900	26,456,037	4,938,000	7,283,750	8,973,378	474
August	57	60	31	7,156	1,982	2,230	32,930,274	8,598,000	7,467,250	7,169,350	351
September	34	40	12	2,949	360	300	18,970,352	80,000	7,918,720	6,384,750	139
October	30	41	7	972	359	......	8,510,000	....	1,765,250	1,775,100	115
November	8	16	15	8	206	9,000	....	....	....	....	....
1897.											
March	6	2	10	18	1,803	......	....	....	....	....	4
April	48	20	43	163	9,891	......	....	....	....	....	....
May	65	35	28	1,074	7,983	19,140	5,162,984	....	1,790,000	2,433,350	132
June	104	69	90	4,800	11,857	21,775	9,619,928	....	2,641,550	2,098,300	227
Total	419	341	272	21,778	40,365	54,345	101,649,575	13,616,000	28,866,520	28,834,228	1,443

Comparative traffic statement showing the total traffic that has passed through the canal since 1890, by fiscal years ending June 30.

Fiscal year.	Steamboats.	Barges.	Passengers.	Merchandise.	Grain.	Lumber.	Logs.	Laths.	Shingles.	Lockage at one lock.
				Tons.	*Bushels.*	*Feet.*	*Feet.*	*Number.*	*Number.*	
1890..	924	477	14,520	71,453	397,788	140,078,329	26,689,300	44,316,167	73,540,370	1,827
1891..	878	357	15,801	45,217	364,878	193,358,089	37,176,150	59,850,595	87,259,690	1,895
1892..	577	191	10,260	12,228	63,210	140,654,084	24,514,000	39,476,926	61,141,137	1,233
1893..	670	234	10,846	83,318	53,257	80,190,519	16,350,200	28,896,260	29,121,020	1,476
1894..	619	312	14,752	43,186	83,650	117,860,783	8,612,000	42,112,415	54,710.727	1,394
1895..	606	340	14,141	22,034	55,729	155,625,800	29,545,910	55,064,988	55,670,204	1,503
1896..	789	313	25,270	40,948	45,176	116,874,111	30,824,000	34,448,534	46,122,200	1,952
1897..	419	613	21,778	40,365	54,345	101,645,575	13,616,000	28,834,220	28,866,520	1,443

Dates of opening and closing of Des Moines Rapids Canal for years 1890–1897.

Year.	Canal opened.	Canal closed.	River opened.	River closed.	Highest water.		Lowest water.	
					Date.	Feet.	Date.	Feet.
1890	Apr. 1	Nov. 20	Jan. 28	Jan. 21	June 30	12.60	Jan. 3	—2.40
1891	....do ...	Nov. 21	Open ...	No close.	Mar. 29	10.80	Nov. 30	—1.60
1892	....do ...	Nov. 23	Feb. 22	Dec. 23	June 30	19.25	Dec. 18	— .80
1893	....do ...	Nov. 15	Mar. 10	Dec. 4	May 15	14.85	Nov. 20	— .90
1894	Mar. 21	....do ...	Mar. 1	Dec. 30	June 3	11.35	Dec. 4	— .90
1895	Mar. 15	Nov. 23	Feb. 26	Dec. 5	Mar. 4	5.10	Dec. 3	—1.40
1896	Apr. 1	Nov. 22	Mar. 3	Jan. 29	June 4	11.90	Jan. 3	—1.40
1897	Mar. 15	....	Mar. 12	....	....	....	....	....

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, July 1, 1897.

COLONEL: I have the honor to submit the following report on "Operating and care of Des Moines Rapids Canal" for the fiscal year ending June 30, 1897:

The canal was closed November 22, 1896, and opened April 1, 1897. From March 15 to 31, 1897, the canal was open for day navigation, the locks being operated by hand to the 22d and after that by steam. Canal was open for navigation two hundred and fifty-two days and closed one hundred and thirteen days. High water marked the early spring of 1897. General rains, especially in the western part of Iowa and in Missouri, culminated in a stage of water of 18.5 feet at the lower lock on April 27, 1897. No damage was done to the canal, though for a few days the water overflowed the road at the Lower Lock and caused some inconvenience. At the Guard Lock the flood was little felt, the highest gauge reading being 9.1 feet on April 25. In the fall of 1896 the packets laid up early, owing to low water and poor business.

Repairs to gates, machinery, and buildings.—The canal was closed on November 26, 1896, and the water drawn off for examination and repair. At the Lower Lock the two upper emptying culvert gates on the east side and all four on the west side were taken out, new cast-iron frames set in the openings, and either new gates put in or the old ones repaired. It was found that the old gates could be fitted with strips of wrought iron for the wearing face against the cast-iron frame by riveting them on and saving the cost of recasting the whole gate, which weighs in the neighborhood of 600 pounds.

A diver had to be employed for the work of putting the caissons in place and making them tight against the bottoms and sides of the lock chamber. The work was done in December, and finally suspended owing to cold weather and ice. Six gates at the upper end of the lock are in bad condition and should have been repaired at the same time. Many of the gates taken out had broken in two from the uneven bearing caused by wear. It is thought that this work, which required a large force of men, a diver, and a steamboat (the *Lucia*) to furnish power for pumping out the caissons, can be done without any caisson or pump by the use of a skillful diver.

On the west side the face of the lock wall about the lower culvert openings, which was shattered by frost, was repaired with new stone.

The upper gates of the Lower Lock had new sheathing put in and the top straight arms of the gate renewed on both leaves.

In September the fire box of the boiler at the Lower Lock gave out on each side of the fire door and was patched. The canal launch *Lucia* furnished the steam to operate the lock machinery during these repairs.

Middle Lock.—The fence at the Middle Lock was repaired after being blown down at the close of the season of 1896. All the machinery at the lock was found to be in good condition except the pipes leading to the upper tower on the east side. These pipes were dug up and replaced. In replacing them we threw some lime in the trench next to the pipes to neutralize the acid of the soil. The pitting and corrosion of the iron pipes points to galvanic action, and the lime may have some effect in neutralizing this action.

Guard Lock.—The old fence, twenty years old, was completely prostrated during the winter of 1896, and was rebuilt in the spring of 1897. The 12-inch boards were sawed into pickets and a picket fence on 6-inch cedar posts substituted for the 8-foot solid board fence. It is thought this fence will last many years and will suffer much less from the wind.

The hydraulic pipes across the lower end of the lock had developed so many leaks last season that it was evident they had to be abandoned or replaced. In November, 1896, a plank and canvas cofferdam was thrown around one-half the length of pipes and the old pipes were taken out and renewed; the cofferdam was then taken up and used on the other half in the same way to renew those pipes. Much trouble and loss of time was occasioned in this work by the want of a skillful diver, and the water broke in several times on account of unskillful management, adding largely to the expense.

Machineshop at Lower Lock.—The lock engineers were kept at work during the winter months on the multitude of repairs necessary to a fleet of steamboats and dredges. The plating apparatus was used to good advantage for nickel-plating triangles and straight edges belonging to the Rock Island and other offices. All the search lights were repaired and put in good order, and the mechanism altered to make them burn their carbons more evenly. The machinery of the *Parke*, *Barnard*, *Lucia*, *Louise*, *Phœnix*, *Edith*, and *Dart* was repaired where necessary, and the engines put aboard the two new tugs, *Pearl* and *Fox*, built at the dry dock for the Illinois River improvement.

Dredging canal.—From July 1 to 19, 1896, and from April 12 to May 31, 1897, the dredge *Phœnix* and towboat *Viren* were employed removing deposit from the canal. In the fall of 1896 a bar formed opposite the mouth of Lamallees Creek, which shut off one-half the canal from use and occasioned a good deal of trouble to passing boats. This shoal was removed and much other good work done, as shown by the accompanying statement:

Material dredged.

Above Guard Lock	cubic yards	1,559.1
Below Guard Lock	do	9,186.9
Below Middle Lock	do	1,321.8
Mouth of Ballingers Creek	do	1,526.9
Mouth of Lamallees Creek	do	33,288.4
Sections 0 to 14	do	10,386.2
Total		57,269.3

Operating dry dock.—The dry dock has been in constant use the whole year, a few private boats having used it from time to time for greater or less repairs. In May the steamer *Saturn* struck rocks on the rapids and sank below the Keokuk and Hamilton Bridge in shoal water. After raising her, with the help of the launches *Lucia* and *Mac*, which happened to be close by, she was docked and her broken bottom repaired, with only a few hours loss of time. This is the class of accidents that the dry dock was especially intended to care for.

Two new towboats, the *Pearl* and *Fox*, were built to the order of Maj. W. L. Marshall, Corps of Engineers, for use on the Illinois River improvement. The U. S. light-house tender *Lily* was docked, according to annual custom, for survey and light repairs.

Total dockage fees received for the year, $71.25.

The following partial list shows work done:

Built.—Two dump boats (20 by 73 feet); towboat *Fox* (65 by 12 feet), and *Pearl* (78 by 17 feet).

Repaired.—Twenty-nine barges, 8 steamboats, 1 pile driver, 1 grasshopper, 2 quarter boats, 4 office boats, and 1 boom.

I have been assisted by Mr. John R. Carpenter, overseer; Mr. Byron Layton, overseer, and Mr. O. S. Willy, clerk, to all of whom my thanks are due for cheerful and efficient service.

Very respectfully, your obedient servant,

M. MEIGS,
United States Civil Engineer.

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

X 4.

OPERATING AND CARE OF GALENA RIVER IMPROVEMENT, ILLINOIS.

During the past year the lock was open for navigation from April 4 to November 19, 1896, and from March 28 to June 30, 1897, a period of 236 days, during which time there passed through 265 steamboats and barges, carrying 714 passengers and 1,679 tons of merchandise.

Under contract, 30,375 cubic yards of material was dredged and removed from Galena River and Harris Slough, at a cost of 19¾ cents per cubic yard. About 210,000 square feet was covered by dredging, the grade being 4 feet at low water. A further large amount of dredging is now needed, and work of this nature will forever recur.

The expenses of the fiscal year ending June 30, 1897, were $8,758.20, including outstanding liabilities, the same being provided for under section 4 of act of July 5, 1884.

Money statement.

June 30, 1897, amount drawn from Treasury under indefinite appropriation	$8,800.00
June 30, 1897, amount expended during fiscal year	8,558.20
July 1, 1897, balance on hand	241.80
July 1, 1897, outstanding liabilities	170.00

Abstract of appropriations.

By act approved—	
September 19, 1890	$100,000
July 5, 1884, for fiscal year ending—	
June 30, 1894	1,500
June 30, 1895	6,000
June 30, 1896	3,400
June 30, 1897	8,800
Total	119,700

Expenditures for operating and care of Galena River improvement for fiscal year ending June 30, 1897.

Month.	Superintendence and office expenses.	Operating.		Repairs to lock.	Dredging.	Total.
		Labor.	Supplies.			
1896.						
July		$170.00				$170.00
August		170.00		$5.00		175.00
September		170.00		9.00	$1,530.33	1,709.33
October	$17.58	170.00		63.57	725.15	976.30
November		170.00			12.70	182.70
December		116.00	$17.42	2.40	30.95	166.77
1897.						
January		80.00				80.00
February		80.00				80.00
March		149.00				149.00
April		170.00	13.10	5.45	1,464.61	1,653.16
May	204.38	170.00			2,814.47	3,188.85
June	6.09				51.00	57.09
Total	228.05	1,615.00	30.52	85.42	6,629.21	8,588.20

Comparative statement of expenditures for operating and care of Galena River improvement for the fiscal years 1894–97.

Year.	Superintendence and office expenses.	Operating.		Repairs to lock.	Dredging.	Total.
		Labor.	Supplies.			
1894	$7.17	$510.00	$4.84	$113.67	....	$635.68
1895	121.16	2,143.50	43.63	2,791.71	$900.00	6,000.00
1896	233.67	2,040.00	33.62	1,092.71	....	3,400.00
1897	228.05	1,615.00	30.52	85.42	6,629.21	8,588.20

Traffic statement of the Galena River improvement for the fiscal year ending June 30, 1897.

Month.	Boats up and down.	Passengers.	Merchandise.	Lockages.
1896.			*Tons.*	
July	25	11	136	19
August	35	29	281	28
September	6	....	3	6
October	13	5	54	12
November	9	4	18	6
1897.				
March	1	2	....	....
April	44	55	507	....
May	60	328	485	15
June	72	280	195	55
Total	265	714	1,679	141

Comparative traffic statement showing total traffic that has passed through Galena River lock, and the dates of opening and closing to navigation for the fiscal years 1894–97.

Year.	Steamboats.	Passengers.	Merchandise.	Lumber.	Shingles.	Laths.	Lockages.	River opened.	River closed.
			Tons.	*Feet.*	*Number.*	*Number.*			
1894	167	1,426	1,228	....	....	....	....	Mar. 12	Nov. 10
1895	471	4,798	1,939	....	....	....	320	Mar. 26	Nov. 21
1896	234	788	812	1,339,000	665,000	974,000	145	Apr. 4	Do.
1897	265	714	1,679	....	....	....	141	Mar. 28	....

NOTE.—For abstract of proposals for dredging in Galena River, see report on improvement work, Missouri River to Minneapolis.

X 5.

MISSISSIPPI RIVER BETWEEN ST. PAUL AND MINNEAPOLIS—CONSTRUCTION OF LOCK AND DAM NO. 2.

During the year some acquisitions of land for lock purposes and of flowage rights were made, the location of lock was decided upon, and preparations for commencement of construction of the lock foundation were about completed.

For further particulars regarding this work, see reports of Chief of Engineers, 1894, page 1682, and 1895, page 2158.

Money statement.

July 1, 1896, balance unexpended	$189,321.17
June 30, 1897, amount expended during fiscal year	4,565.13
July 1, 1897, balance unexpended	184,756.04
July 1, 1897, outstanding liabilities	301.88
July 1, 1897, balance available	184,454.16
Amount (estimated) required for completion of existing project	*397,357.33
Amount that can be profitably expended in fiscal year ending June 30, 1899	397,357.33

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations.

By act approved—	
August 17, 1894	$51,000.00
July 13, 1892 (allotted by act of August 17, 1894)	49,877.67
By act of June 3, 1896	100,000.00
Total	200,877.67

X 6.

SURVEY OF EAST BANK OF MISSISSIPPI RIVER BETWEEN OQUAWKA AND DALLAS CITY, ILLINOIS, WITH A VIEW TO THE IMPROVEMENT OF NAVIGATION BY PREVENTING THE OVERFLOW OF THE NATURAL AND ARTIFICIAL BANKS AND BY DEEPENING THE CHANNEL.

[Printed in House Doc. No. 159, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., December 29, 1896.

SIR: The river and harbor act of June 3, 1896, contains an appropriation for improving Mississippi River from St. Paul to the mouth of the Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> Along the east bank of said river, from at or near the city of Oquawka, Illinois, to at or near Dallas City, in the said State, with a view to the improvement of navigation by preventing the overflow of the natural and artificial banks and by deepening the channel.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report of December 21, 1896, with map,† by that officer, giving the results of the survey made during the months of October and November, 1896.

The project submitted by Colonel King contemplates the construction of levees about 40 miles long, and he estimates the cost at $340,250. He states at some length the advantages to be derived from the proposed levee as a protection to land subject to overflow, but is of opinion that the construction of such banks as proposed will not be of any benefit to navigation, and in this opinion I concur.

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* The amount reported in the annual report for 1896 was erroneous and should have been $397,357.33.

† Not reprinted. Printed in House Doc. No. 159, Fifty-fourth Congress, second session.

Attention is invited to Colonel King's suggestion that if this work is undertaken by the General Government the right of way should be donated to the United States.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., December 21, 1896.

GENERAL: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for improvement of Mississippi River from Saint Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated as follows:
>
> * * * Along the east bank of said river from at or near the city of Oquawka, Illinois, to at or near Dallas City, in the said State, with a view to the improvement of navigation by preventing the overflow of the natural and artificial banks and by deepening the channel.

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress in ordering this survey is that the Government desires an estimate of the cost of preventing the overflow of the east bank of the river between the points named by the erection of artificial banks where needed.

This survey was made during the months of October and November, 1896, by a small party in charge of Asst. Engineer C. W. Durham, assisted by Insp. E. E. Barrett and a portion of the crew of the United States snag boat *General Barnard.*

Transit and level lines were run from a point above high water near Oquawka, down the east bank of the Mississippi River to a point above high water on the north side of Camp Creek, about 1 mile above Dallas City.

The high-water discharge of Henderson River and Ellison and Honey creeks being too large to be readily carried away by ordinary drainage culverts and sluices, lines were run on both sides of these streams from the Mississippi River to the bluffs, and the estimate includes the cost of cross levees. All of the remaining water courses will be crossed by the levee—eleven of them, however, being furnished with drainage culverts, the probable cost of which is included in the estimate. These outlets are located at Stations 173, 203, 596, 1020, 1481, 1556, 1688, 1933, 1960, 2050, and 2076.

A great number of bench marks were established, many high-water marks and water surfaces were taken, and calculations were made of the discharge of the various small sloughs and creeks to be crossed by the levees.

An earthen bank is proposed and estimated for, with a 4-foot width of crown, and a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered best for this part of the river, having been successfully used for many years in the Sny Island levee and in the Warsaw to Quincy levee. The grade of the top of the bank is placed at 3 feet above high water of 1888, which is the standard high water for this vicinity, it having been higher in that year than in any since 1851.

The proposed levees will be about 40 miles long, and will contain 2,204,335 cubic yards of earthwork, including muck ditch and road crossings.

It is suggested that, as in the case of the Flint Creek to Iowa River levee (now in course of construction), right of way should be donated to the United States if this work is undertaken.

The accompanying tracing gives the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. There are also on the tracing a detailed estimate of quantities and a small-scale map showing the river and country adjacent.

Estimate for artificial bank to prevent overflow of the east bank of the Mississippi River from Oquawka to Dallas City.

2,204,335 cubic yards earthwork, including engineering contingencies, at 15 cents per cubic yard	$330,650
Drainage pipes, with valves and necessary stonework	9,600
Total	340,250

While I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, yet it may perhaps be of interest to submit some figures concerning the advantage to the land inclosed. Roughly estimated, the land subject to overflow, which will be protected by the construction of this levee, is about 21,000 acres in extent, and its value will appreciate from $2 an acre, at which it is now valued, to about $25 per acre—a gain of $23 per acre, or $483,000. It will be noticed that the strip of land to be benefited by this levee is of very unequal width, being narrower at the lower end, so that the lower third of the levee will protect only about one-seventh of the land inclosed by the whole levee. Attention is also invited to the fact that considerable portions of the levee are upon small branches of the Mississippi River, extending several miles back, to reach higher ground, and that in many cases the protection of these cross levees involves improvement or protection of the banks of the small streams upon which they are located, these streams cutting into their banks and undermining the levees. This has occurred upon the Iowa River, and considerable expense has been involved in riprapping the banks of that stream to protect the levees.

In other cases these small streams have been allowed to become obstructed with willows and other vegetable growth, so that when sudden and heavy rains occur they will overflow their banks and destroy the levee, sometimes rising very much higher than any record of former floods would indicate. In one instance it has been necessary to cut a new levee to allow the overflow of one of these streams to reach the river, which happened to be low at that time. Otherwise the land for the protection of which the levees were built would have been overflowed, although the Mississippi at that time was at a comparatively low stage. In contingencies like these it becomes necessary to cooperate with the commissioners appointed under State laws, and although this has been done without any clashing of interest thus far, it is quite probable that cases may arise where difficulty may occur, and if possible some provision should be made in advance against any such contingency.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

X 7.

SURVEY OF EAST SIDE OF MISSISSIPPI RIVER BETWEEN DRURYS LANDING AND NEW BOSTON, ILLINOIS, WITH A VIEW TO THE IMPROVEMENT OF NAVIGATION BY PREVENTING THE OVERFLOW OF THE NATURAL AND ARTIFICIAL BANKS, AND BY DEEPENING THE CHANNEL.

[Printed in House Doc. No. 212, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1897.

SIR: The river and harbor act of June 3, 1896, contains an appropriation for improving Mississippi River from St. Paul to the mouth of the Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> On the east side of the Mississippi River, commencing at Drurys Landing, in Rock Island County, State of Illinois, and running along the east bank of said river to New Boston, with a view to the improvement of navigation by preventing the overflow of the natural and artificial banks, and by deepening the channel.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report of January 8, 1897, with map,* by that officer, giving the results of the survey made during the months of September and October, 1896.

The project submitted by Colonel King contemplates the construction of a levee about 30 miles long, and he estimates the cost at $243,245. He states the advantages to be derived from the proposed levee as a protection to land subject to overflow, but is of the opinion that the construction of such banks as proposed will not be of any benefit to navigation, and in this opinion I concur.

Attention is invited to Colonel King's suggestion that, if this work is undertaken by the General Government, the right of way should be donated to the United States.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 212, Fifty-fourth Congress, second session.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 8, 1897.

GENERAL: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for the improvement of the Mississippi River from St. Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated as follows:
>
> On the east side of the Mississippi River, commencing at Drurys Landing, in Rock Island County, State of Illinois, and running along the east bank of said river to New Boston, with a view to the improvement of navigation by preventing the overflow of the natural and artificial banks, and by deepening the channel. * * *

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress in ordering this survey is that the Government desires an estimate of the cost of preventing the overflow of the east bank of the river between the points named by the erection of artificial banks where needed.

The survey was made during the months of September and October, 1896, by a small party in charge of Assistant Engineer C. W. Durham, assisted by Inspector E. E. Barrett and a portion of the crew of the U. S. snag boat *General Barnard.*

Transit and level lines were run from a point above high water near Drurys Landing down the east bank of the Mississippi River to the mouth of Sturgeon Bay, and thence up the west bank of Sturgeon Bay for a short distance, and across the bay at a favorable locality to a point above high water in the sand ridge about 2 miles above New Boston.

At Copperas Creek, about 7 miles below Drurys Landing, lines were run on both sides of the creek from the river to the bluffs, it appearing best to estimate for cross levees, the discharge of the creek at high water being too large to be readily carried away by culverts or sluiceways.

A great number of bench marks were established, many high-water surfaces were taken, and calculations were made of the discharge of the various small sloughs and creeks to be crossed by the levee.

An earthen bank is proposed and estimated for, with a 4-foot width of crown and a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered best for this part of the river, having been successfully used for many years in the Sny Island levee and in the Warsaw to Quincy levee. The grade of the top of the bank is placed at 3 feet above high water of 1892, which is the standard high water for this vicinity, it having been higher in that year than in any since 1851. The proposed levee will be about 30 miles long and will contain 1,589,633 cubic yards of earthwork, including muck ditch and road crossings.

Drainage outlets were found to be necessary at the mouth of Fourth Slough, at English Bend, and Dog Lake, and the probable cost of the necessary culvert pipes and masonry is included in the estimate.

It is suggested that, as in the case of the Flint Creek to Iowa River levee (now in course of construction), right of way should be donated to the United States if this work is undertaken.

The accompanying tracing gives the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. There are also on the tracing a detailed estimate of quantities and a small-scale map, showing the river and country adjacent.

Estimate for artificial bank to prevent overflow of east bank of Mississippi River from Drurys Landing to New Boston.

1,589,633 cubic yards earthwork, including engineering and contingencies, at 15 cents per cubic yard	$238,445
Drainage pipes, with valves and necessary stonework	4,800
Total	243,245

While I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, yet it may be perhaps of interest to submit some figures concerning the advantage to the land inclosed. The land subject to overflow, which will be protected by the construction of this levee, is about 30,000 acres in extent, and its value will appreciate from $2 per acre, its present average value, to about $25 per acre, a gain of $23 per acre, or $690,000.

Attention is invited to the fact that about 5 miles of the levee are upon Copperas Creek, and that in many cases the protection of these cross levees involves improvement or riprapping of the banks of the small streams upon which they are located, these streams cutting into their banks and undermining the levees. This has occurred upon the Iowa River, and considerable expense has been involved in riprapping the banks of that stream to protect the levees. In other cases these small streams have been allowed to become obstructed with willows and other vegetable growth, so that when sudden and heavy rains occur they will overflow their banks and destroy the levee, sometimes rising very much higher than any record of former floods would indicate.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

X 8.

SURVEY OF LA CROSSE HARBOR, WISCONSIN.

[Printed in House Doc. No. 210, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 11, 1897, with map,* by Lieut. Col. W. R. King, Corps of Engineers, of the results of a survey of La Crosse Harbor, Wisconsin, made to comply with the provisions of the river and harbor act of June 3, 1896.

The plan of improvement contemplated is shown in detail on the map, and meets with the approval of steamboat men generally, the city engineer, and the Board of Trade of La Crosse.

It is proposed to build a dam or bulkhead of brush and rock in the Mississippi River 1,575 feet long. A smaller dam of similar material, 450 feet long, is provided for, and is intended to catch deposits from La Crosse River. This dam will run shoreward from the upper end of the long dam to the south of La Crosse River.

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*Not reprinted. Printed in House Doc. No. 210, Fifty-Fourth Congress, second session.

Provision is also made for dredging the bar on the Mississippi River side of the proposed long dam to a depth of 4½ feet below low water and for depositing the dredged material, estimated at 55,000 cubic yards, on the inside of the bulkhead. This material will provide an additional landing space of 800 linear feet and fill to 1 foot above high water a portion of the space inside the bulkhead. Certain other filling, to be done at the expense of the city of La Crosse, is also provided for.

The work herein outlined to be undertaken by the United States is estimated to cost $17,000. An appropriation of $5,000, made by the river and harbor act of June 3, 1896, for improving this harbor, is still available, leaving $12,000 yet to be appropriated should the within project be carried out.

In order to insure a current along the main dam or bulkhead, thereby preventing the formation there of another bar, Colonel King proposes to carry out at this time a portion of the general project for the improvement of the Mississippi River at this locality, the work to consist of dam construction at Grand Island and Island No. 105. The cost of these dams should be paid from the general appropriation for improving the river between Missouri River and Minneapolis.

Attention is respectfully invited to the following recommendation of Colonel King:

> If it is thought advisable to appropriate funds for the improvement of this landing, I would respectfully recommend that the amount be not taken from the appropriation for the general improvement of the river, and that a proviso be added that no expenditure shall be made for this purpose by the United States until the city of La Crosse shall have taken the necessary steps to carry the sewers across the area to be filled in, so as to discharge outside of the bulkhead herein proposed.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 11, 1897.

GENERAL: The river and harbor act of June 3, 1896, provides for a survey of "La Crosse Harbor, Wisconsin." This survey was assigned to me by letter of the Chief of Engineers dated September 5, 1896.

The survey was made in November, 1896, by Assistant Engineer W. A. Thompson, who has rendered a report, estimates, and map, the latter of which is forwarded herewith. There are a large number of maps of this locality on file in this office, running from 1866 to 1895, so that but little field work was necessary to gain the needed information. These maps show the changes in bar and channels from year to year.

La Crosse Harbor, like most Upper Mississippi River harbors, is simply the river front or wharf of the city. In the early days of steamboating and down to about 1882, there was a good landing from Jay street to Pine street, about 2,400 feet, and also along the east side of Black River, above La Crosse River, for a half mile. In those days the channel of the Mississippi River joined that of the Black above the mouth of the La Crosse River, and the water of both the first-named streams ran together in a deep and wide groove along the city front, and with sufficient velocity to carry away or hold in check the débris thrown out from the La Crosse River.

Since about 1882 the channel of the Mississippi River has moved by degrees lower down, so that it now strikes the eastern shore some distance below the mouth of La Crosse River, the change resulting in great improvement to through navigation. But the sluggish current of Black River, now unaided by that of the Mississippi, is no longer able to handle and restrain the sand and mud deposits from La Crosse River, so that to-day the bar has increased to such an extent as to prevent at low stages landings in Black River and also in the harbor of La Crosse from Pine street to a point about midway between Main and State streets. A change in the channel of the La Crosse River, artificially made in 1884, has perhaps largely accelerated deposits. The bridge crossing the river at Mount Vernon street still further restricts the available length of the wharf to about 500 feet, it not being safe to land nearer the bridge than Pearl street. The railroad tracks along the levee also lessen the space for handling freight. The eddy below the bar is troublesome, and sometimes, on account of the nearness of the bridge, makes the departure of boats dangerous. No landing below the bridge is practicable, sawmills and other manufacturing concerns occupying nearly all the shore between the bridge and La Plume Island.

Nearly all the sewage of La Crosse accumulates in the harbor, there being no current to carry it away.

The project presented, which is shown in red on the map, meets with the approval of steamboat men generally, the city engineer, and the local board of trade.

It is proposed to build a dam or bulkhead of brush and rock to an elevation of 8 feet above low water of 1864, commencing at the center of Main street and running upstream to a point about 1,000 feet from shore nearly opposite the foot of Badger street. This dam, which will have a preponderance of brush—the cheaper material—will be 1,575 feet long, the lower 800 feet being on a flat curve and the remainder straight line. A smaller dam, built to an elevation of 4 feet above low water, for the purpose of catching deposits from La Crosse River, will run shoreward from the upper end of the long dam until it meets the 4-foot contour on south side of La Cross River—about 450 feet.

It is further proposed to dredge (with a suction or hydraulic dredge, if possible) the bar on the river side of the large dam to a depth of 4½ feet below low water and deposit the material, estimated at 55,000 cubic yards, on the inside of the bulkhead, commencing at the lower end and working upstream. This material if properly used will make an additional 800 linear feet of landing and will fill to 1 foot above high water the space inside the bulkhead up as far as the north line of Vine street.

The space within the bulkhead and the line of the low dam produced to shore is 18.6 acres, and it is expected that the city of La Crosse will fill by degrees, as funds become available, the remainder of the area not filled by the United States with the dredged material, and convert the same into a park. This work, comprising about 400,000 cubic yards, may never be carried out; but, however that may be, the execution of this project as recommended will provide, as before stated, about 800 feet of wharf in addition to the 500 feet now available, which will probably be sufficient for some years to come.

To insure a current along the main dam or bulkhead, and thereby prevent the formation of another bar there, I propose to carry out at this time a portion of the general project for improvement of the Mississippi River in this locality, by building the four wing dams from Grand Island and the lateral dam at foot of Island No. 105 (shown on map). The wing dams are to be built to an elevation of 3 feet above low water, and will have low extensions (shown by dotted red lines) from 4 to 6 feet below low water. The lateral dam will also be built to an elevation of 3 feet above low water, and of such a length as to contract the waterway of Black River at low water to a width of 500 feet.

The cost of the wing and lateral dams should be paid from the general appropriation for improving Mississippi River from Missouri River to Minneapolis.

Estimate for improvement of La Crosse Harbor, Wisconsin.

Long dam or bulkhead, Mississippi River:		
Rock, 4.231 cubic yards, at $1	$4,231.00	
Brush, 6,874 cubic yards, at 35 cents	2,405.90	
		$6,636.90
Cross dam, La Crosse River:		
Rock, 548 cubic yards, at $7	548.00	
Brush, 918 cubic yards, at 35 cents	321.30	
		869.30
Dredging bar outside of bulkhead and transferring material by hydraulic dredge:		
Sand and mud, 55,000 cubic yards, at 15 cents		8,250.00
Engineering and contingencies		1,243.80
Total		17,000.00

I would say that an appropriation of $5,000 for La Crosse Harbor was included in the river and harbor act of June 3, 1896, so that only $12,000 is needed to carry out the project.

If it is thought advisable to appropriate funds for the improvement of this landing, I would respectfully recommend that the amount be not taken from the appropriation for the general improvement of the river, and that a proviso be added that no expenditure shall be made for this purpose by the United States until the city of La Crosse shall have taken the necessary steps to carry the sewers across the area to be filled in, so as to discharge outside of the bulkhead herein proposed.

Very respectfully, your obedient servant,

W. R. King,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. Craighill,
Chief of Engineers, U. S. A.

X 9.

SURVEY OF WEST SIDE OF MISSISSIPPI RIVER, COMMENCING NEAR LAGRANGE, ABOVE HIGH WATER, AND RUNNING ALONG THE BANK OF THE RIVER TO NEAR THE RAILROAD BRIDGE OVER MISSISSIPPI RIVER ABOVE HANNIBAL, MISSOURI, WITH THE VIEW OF IMPROVING NAVIGATION BY PREVENTING THE WATER FROM OVERFLOWING THE NATURAL AND ARTIFICIAL BANKS ALONG THAT PART OF THE RIVER AND DEEPENING THE CHANNEL.

[Printed in House Doc. No. 244, Fifty-fourth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, D. C., January 27, 1897.

Sir: The river and harbor act of June 3, 1896, contains an appropriation for improving Mississippi River from St. Paul to the mouth of the Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> West side of the Mississippi River, commencing at a point near Lagrange, in the county of Lewis and State of Missouri, above high water, running along the bank of the river to a point near the railroad bridge over the Mississippi River, near and above the city of Hannibal, in the county of Marion, and State of Missouri, with the view of improving navigation by preventing the water from overflowing the natural and artificial banks along that part of the river and deepening the channel.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report of January 20, 1897, with map,* by that officer, giving the results of the survey made during the months of September and October, 1896.

The project submitted by Colonel King contemplates the construction of levees, and he estimates the cost at $341,761.

He states the advantages to be derived from the proposed levees as a protection to land subject to overflow, but is of opinion that the construction of such banks as proposed will not be of any benefit to navigation, and in this opinion I concur.

Attention is invited to Colonel King's suggestion that, if this work is undertaken by the General Government, right of way should be donated to the United States.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 20, 1897.

GENERAL: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for the improvement of the Mississippi River from St. Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated, as follows:
>
> * * * * * * *
>
> Also on the west side of the Mississippi River, commencing at a point near Lagrange, in the county of Lewis and State of Missouri, above high water, running along the bank of the river to a point near the railroad bridge over the Mississippi River, near and above the city of Hannibal, in the county of Marion and State of Missouri, with the view of improving navigation by preventing the water from overflowing the natural and artificial banks along that part of the river and deepening the channel.

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress is that the Government desires an estimate of the cost of preventing the overflow of the west bank of the Mississippi River between the points named by the erection of artificial banks where needed.

The survey was made by a party in charge of United States Civil Engineer M. Meigs, assisted by Surveyor R. Monroe, in September and

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* Not reprinted. Printed in House Doc. No. 244, Fifty-fourth Congress, second session.

October, 1896. Mr. Meigs's report and a map of the survey are herewith inclosed, and should be referred to for details.

The bottom lands between Lagrange and the lower limit of the survey, near Hannibal Bridge (about 25 miles by transit line), are traversed by four considerable streams, called rivers, which divide the territory into five districts.

1. *Lagrange to North Fabius River.*—The proposed levee for this district commences at Lagrange and runs down the Mississippi to a point near mouth of Fabius River, and thence up North Fabius River to the bluffs. This district contains about 16,480 acres of very rich bottom land, chiefly prairie and mostly under cultivation, and levee protection would enhance its value about $20 per acre, or $329,600.

There is one large creek—Durgans—for which an outlet of masonry, with 252 square feet of openings, is provided in the estimates. A similar opening will also be necessary near the mouth of Fabius River.

2. *North Fabius to South Fabius River.*—Between these streams there are 4,960 acres of bottom land, mostly swamp and heavy timber, very little settled. No estimate was made for leveeing this district, as the expense of levees would be very great and the amount of benefit comparatively small.

3. *South Fabius to North River.*—The proposed levee for this district commences at a point in the bluffs above high water and runs down the south side of South Fabius River to the Mississippi, down the Mississippi to North River, and up north side of North River to the bluffs. This district contains about 4,480 acres of rich bottom land, a great part of which is cultivated. The increase in value of this land will be about $89,600. One outlet is needed near Station 6, North River, and it is proposed to place there six lines of 48 inch iron pipe, with proper valves and retaining walls.

4. *North River to South River.*—Between these streams there are 2,400 acres of bottom land, principally swamp. No estimate was made for levees in this district.

5. *South River to Hannibal.*—The proposed levee for this district commences at the bluffs on south side of South River and runs down South River to the Mississippi, thence down the Mississippi to and across the foot of Bayou St. Charles, near Hannibal, to the high ground. This district contains about 11,360 acres of very rich bottom land, the most of which is at present covered with heavy timber. Levee protection would increase the value of this land at least $25 per acre, or $284,000. To properly drain this district ten lines of 48-inch iron pipe will be required at the foot of Bayou St. Charles.

The grade of the crown of the levees is taken at 3 feet above high water of 1888, for which sufficient data were found to make a very good approximation to the true grade of high water in the river. A bank is estimated for with a 4-foot width of crown and a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered the best for the Upper Mississippi River, having been successfully used for many years in the Sny Island levee and in the Warsaw to Quincy levee.

Estimates for artificial bank to prevent overflow of the west bank of the Mississippi River between Lagrange and Hannibal, Mo.

1. Lagrange to North Fabius River district	$151,936
3. South Fabius to North River district	61,988
5. South River to Hannibal district	127,837
Total	341,761

The total probable increase in value of land in above districts will be about $703,200.

Although I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, it would appear that the probable increase in value of land is much greater than the estimated cost of the work.

Attention is invited to the fact that, in order to make this improvement effective, a considerable portion of the work estimated for is not, properly speaking, on the Mississippi River at all, but on several small rivers, which are not navigable streams. Certain portions of these levees are above the flood level of the Mississippi, but are needed to keep the floods of the streams above referred to from filling the area inclosed by the levees—a condition of things that might prevail even where the Mississippi proper is entirely within its natural banks.

It is suggested that, as in the case of the Flint Creek to Iowa River levee (now in course of construction), right of way should be donated to the United States if this work is undertaken.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 9, 1897.

COLONEL: I have the honor to submit the following report on a survey between Lagrange and Hannibal, Mo., with an estimate of cost of constructing levees "with the view of improving navigation by preventing the Mississippi River from overflowing its banks and thereby deepening the channel."

A survey party was put in the field September 20, 1896, in charge of Mr. R. Monroe, surveyor. The survey was made between September 20 and October 21. The weeds and brush were so thick and the limits of time and expense so small that it was not possible to run as many lines as desirable. The grade of the crown of the levees was taken at 3 feet above high water of 1888, for which sufficient data were found to make a very good approximation to the true grade of high water in the river. The survey extends from Lagrange to Hannibal Bridge, a distance by the transit line of 25 miles.

The area which it is proposed to inclose by levees is of an average width of 3 miles, and the soil of the bottom lands is of great fertility and richness. From Lagrange to the North Fabius River the country is open and a good deal of it is under cultivation, and farm land is probably worth from $10 to $50 per acre, depending on location. No doubt the construction of efficient levees will enhance the value from $20 to $30 per acre, as it has done in other cases farther up the Mississippi where the Government has built levees.

Between Lagrange and the Fabius River there is one considerable creek—Durgans—which expands into a swamp and afterwards discharges into the Mississippi 2 miles above Quincy Bridge. No provision is considered necessary for restraining this creek beyond a liberal outlet for its water at its mouth. A similar outlet will have to be provided near the mouth of the Fabius River. Considered as a whole, the land in question is crossed by no less than four considerable streams. Of these the North Fabius is the largest and is a river which in times of flood pours an immense quantity of water into the Mississippi, and often inundates the whole country nearly to Lagrange. Some small attempts have been made at levees along the upper part near the bluff, but they are weak and often overtopped by floods. North and South Fabius drain about 1,000 square miles of territory, and their sources are in the vicinity of Glenwood Junction, Mo., a distance of about 90 miles northwest of its junction with the Mississippi. They flow through a broken and hilly country, and their freshets are sudden and violent. The South Fabius is the smaller stream and joins the North Fabius just before it enters the Mississippi. Between the two streams the country is mostly swamp and heavy timber, and is very little settled. There are few houses or roads in the bottoms, and those who own lands mostly live at the bluff above high-water mark. North River, the next stream in size, is smaller than the Fabius, but it is subject also to heavy and sudden freshets. South River, the smallest of the four streams, is the least subject to inundation. South of all these streams is the so-called Bayou St. Charles, a slough that cuts off a very considerable tract of land, and after leaving the Mississippi finds its way back to the bluff, and after a course of 7 miles enters the main river again 1 mile above the bridge at Hannibal. The island between Bayou St. Charles and the main river is mostly covered with timber, and slopes back from the Mississippi toward the bluff; but the soil is most fertile, and could be cultivated to advantage were it not for the floods of the Mississippi.

The lines in red are actually surveyed lines, and all topography near the levees is from this survey. The bluffs and the river bank on the east side are from the Commission map, published by the Mississippi River Commission.

In my estimate no provision is made for a levee between the two Fabius rivers nor between North River and South River. These are inconsiderable areas of swampy, wild land, which it seems useless at present to take into account. Owing to the lowness of the ground you will perceive that all levees will have to go back to the bluff. What I said about outlets in a report[*] on the Alexandria-Canton survey will apply with the same or greater force to these districts, which are lower, and where, if possible, the rainfall is greater. Last July 8 inches of rain fell in Hannibal in less than a week, and within one week of the present writing 5 inches fell in forty-eight hours. If the land is not to be inundated by the rainfall ponded up behind the levees, no less liberal estimate for the drainage at the foot of each district must be made than in the district from Alexandria to Canton. The levels and profiles refer to the Cairo datum, established by the Mississippi River Commission. The bench marks of that survey served to check the levels and transit work most admirably.

The following is an estimate of the areas of land affected by the proposed work:

	Acres.
Lagrange to mouth of Fabius River	16,480
Between South Fabius and North rivers	4,480
Between South River and foot of Bayou St. Charles	11,360
Total	32,320

Between North and South Fabius rivers the area is 4,960 acres, and between North and South rivers 2,400 acres, the protection of which land is not at present considered.

I append an estimate for a levee of a 4-feet width of crown and with slopes of 1 in 3 on the outside of the levee and 1 in 2 on the inside. No estimate of land damages is made, as it is assumed that the land necessary for the levee will be donated.

Estimates for artificial bank to prevent overflow of the west bank of the Mississippi River between Lagrange and Hannibal, Mo.

1. Lagrange to North Fabius River district:	
461,824 cubic yards earthwork, from Lagrange to mouth of Fabius River, at 15 cents	$69,274
152,291 cubic yards earthwork on north bank of North Fabius River, at 15 cents	22,844
Two outlet sluices of masonry, 252 square feet of openings, one at mouth of Durgans Creek and the other near mouth of Fabius River	40,000
Engineering and contingencies, at 15 per cent	19,818
Total	151,936
3. South Fabius to North River district:	
106,991 cubic yards earthwork on Mississippi River, at 15 cents	16,049
119,048 cubic yards earthwork on South Fabius River, at 15 cents	17,857
113,313 cubic yards earthwork on North River, at 15 cents	16,997
Outlet at Station 6, North River: 6 lines of 48-inch iron pipe, with proper valves and retaining walls	3,000
Engineering and contingencies, at 15 per cent	8,085
Total	61,988
5. South River to Hannibal district:	
566,461 cubic yards earthwork on Mississippi River, at 15 cents	84,969
144,625 cubic yards earthwork on South River, at 15 cents	21,694
Outlet at Bayou St. Charles: 10 lines of 48-inch iron pipe, with proper valves and retaining walls	4,500
Engineering and contingencies, at 15 per cent	16,674
Total	127,837

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[*] Printed in House Doc. No. 223, Fifty-fourth Congress, second session.

Summary of estimates.

Lagrange to North Fabius River	$151,936
South Fabius to North River	61,988
South River to Hannibal	127,837
Total	341,761

Respectfully submitted.

M. MEIGS,
United States Civil Engineer.

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

X 10.

SURVEY OF EGYPTIAN LEVEE ALONG THE SOUTH BANK OF DES MOINES RIVER TO OR NEAR MISSISSIPPI RIVER AT ALEXANDRIA, MISSOURI; THENCE ALONG THE WEST BANK OF SAID RIVER TO TERMINUS OF SAID EGYPTIAN LEVEE; AND ESTIMATE OF COST OF RAISING AND STRENGTHENING SAID LEVEE SO AS TO CONFINE THE WATER TO THE RIVER AND THEREBY DEEPEN THE CHANNEL AND IMPROVE NAVIGATION.

[Printed in House Doc. No. 223, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 25, 1897.

SIR: The river and harbor act of June 3, 1896, contains an appropriation for improving Mississippi River from St. Paul to the mouth of the Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> Egyptian levee, beginning at a point on the Des Moines River, in the county of Clark, State of Missouri, running along the south bank of said river to or near the Mississippi River at Alexandria, thence along the west bank of said river to terminus of said Egyptian levee, and estimate the cost of raising and strengthening said levee so as to confine the water to the river and thereby deepen the channel and improve navigation.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report of January 18, 1897, with map,* by that officer, giving the results of the survey made during the months of October and November, 1896.

The project submitted by Colonel King contemplates the raising and strengthening of existing levees and the building of new ones where needed, and he estimates the cost at $285,500.

He states the advantages to be derived from the proposed levees as a protection to land subject to overflow, but is of opinion that the construction of such banks as proposed will not be of any benefit to navigation, and in this opinion I concur.

Attention is invited to Colonel King's suggestion that, if this work is undertaken by the General Government, the right of way should be donated to the United States.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 223, Fifty-fourth Congress, second session.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 18, 1897.

GENERAL: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for improvement of the Mississippi River from St. Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated, as follows: * * *
>
> Also of the Egyptian Levee, beginning at a point on the Des Moines River, in the county of Clark, State of Missouri, running along the south bank of said river to or near the Mississippi River at Alexandria; thence along the west bank of said river to terminus of said Egyptian Levee; and estimate the cost of raising and strengthening said levee so as to confine the water to the river and thereby deepen the channel and improve navigation.

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress is that the Government desires an estimate of the cost of raising and strengthening existing levees and of building new ones where needed.

The survey was made by a party in charge of United States Civil Engineer M. Meigs, assisted by Surveyor R. Monroe, in October and November, 1896. Mr. Meigs's report and a map of the survey are herewith inclosed, and should be referred to for details.

The survey at first embraced the territory inclosed by the Des Moines and Fox rivers and their levees, but was afterwards extended from Alexandria to Canton in order to make sure of including the whole area covered by the clause of the act above quoted. It is probable that Congress desired only an examination of the ground first mentioned; but, as the information has been gained, the district between Alexandria and Canton will also be considered.

The high-water slopes and the crown of the proposed levees along the Mississippi River from Alexandria to Canton were placed at the same elevations as at opposite points on the Warsaw to Quincy Levee on the Illinois side of the river, the grade being 3 feet above high water of 1892. This was done because of the impossibility of obtaining a sufficient number of accurate high-water marks on the west side.

Where new levees are estimated for, they are given a 4-foot crown, with a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered best for the Upper Mississippi River, having been successfully used for many years in the Sny Island Levee and in the Warsaw to Quincy Levee.

The profile shows a continuous line from St. Francisville, on the Des Moines River, to near Canton, on the Mississippi River, and various side lines running up the tributaries flowing into the Mississippi between Alexandria and Canton. The tract of land in question is bounded on the east by the Mississippi River, on the north by the Des Moines River, and on the west by the bluffs—a triangular area about 6½ miles in its widest part and extending from Alexandria to Canton, a distance of 11½ miles. It contains about 32,500 acres of reclaimable land.

For convenience in description and for other reasons the area to be inclosed has been divided into two districts. The upper one, called the Egyptian Levee district, comprises the bottom lands between the Des Moines and Fox rivers, and the lower, called the Gregory district, the lands below Fox River.

1. *Egyptian Levee district.*—This district, which lies between the Des Moines and Fox rivers, or, in other words, between the Egyptian and Fox levees, has been long settled and is extensively cultivated. The

so-called Egyptian Levee protects it from floods of the Des Moines River and the levee on the north side of Fox River protects it from the Fox.

These levees are of good dimensions and probably strong enough for their purpose, provided the Egyptian Levee is protected against the erosion of the banks of the Des Moines. As will be seen on the map, the Des Moines River at each bend has in time past encroached upon the levee and destroyed it. To make the bed of the Des Moines River stable appears to be the simplest way of maintaining the Egyptian levee, and this can be done by protecting the shore of each bend where it approaches the levee. It will also be necessary to rebuild and strengthen about 1½ miles of the Egyptian Levee and to build a new levee from Alexandria down the Mississippi River and up the Fox River to a junction with the Fox River Levee. A drainage outlet of stone or iron and with 252 square feet of openings is estimated for. This outlet will be placed near the southeast corner of the district, emptying into old Fox River, and will, it is thought, be of sufficient capacity to rapidly carry off the water of floods caused by breaks in the levees or by abnormal rains.

The Egyptian Levee district contains about 11,000 acres of bottom land, and thorough levee protection will insure an increase in the value of the land of about $20 per acre, or $220,000.

2. *Gregory district.*—The land in this district is similar in character to that of the Egyptian Levee district. There run through it Honey Creek and Sugar Creek, both of which in times of flood carry considerable water, although much less than the Fox River.

It is proposed to enlarge and strengthen the levee on the south side of Fox River, building new embankment where necessary, and to carry it across the river so as to divert that stream into its old channel, emptying into the Mississippi just below Alexandria. In carrying out this plan, it will be necessary to remove the railroad embankment which crosses the upper mouth of the Fox River, and to build in its place a bridge. It is further proposed to construct a new levee from the east end of the Fox River Levee to the Mississippi River, and thence down the Mississippi to a point about 4 miles above Canton, where the bluffs come near the river.

Two drainage outlets will be needed and are estimated for, the same being planned of the same dimensions as the one in the upper district. One of these outlets is located at the mouth of Fox River, to carry the water of Sugar and Honey creeks, and the other at the lower end of the district near the head of Tully Island.

The area of the Gregory district bottom land is about 21,500 acres, and thorough levee protection will increase its value about $20 per acre, or $430,000.

Estimate for artificial bank to prevent overflow of west bank of Mississippi River at the Egyptian Levee and between Alexandria and Canton.

1. Egyptian Levee district	$92,000
2. Gregory district	193,500
Combined estimate for both districts	285,500
Probable increase in value of land	650,000

Although I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, it seems that the probable increase in value of land is far in excess of the estimated cost of the work.

Attention is invited to the fact that in order to make this improvement effective a considerable portion of the work estimated for is not, properly speaking, on the Mississippi River at all, but on the Des Moines and Fox rivers, which are not navigable streams. Certain portions of these levees are above the flood level of the Mississippi, but are needed to keep the floods of the streams just mentioned from filling the area inclosed by the levees—a condition of things that might prevail even when the Mississippi proper is entirely within its natural banks.

It is suggested that, as in the case of the Flint Creek to Iowa River Levee (now in course of construction), right of way should be donated to the United States if this work is undertaken.

Very respectfully, your obedient servant,

W. R. KING,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. M. MEIGS, UNITED STATES CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, January 8, 1897.

COLONEL: I have the honor to submit the following report on the survey of the Egyptian Levee, and of the levee survey south of Alexandria to the vicinity of Canton, on the Mississippi River:

In compliance with your instructions of August 24, 1896, a party was placed in the field under the charge of Mr. R. Monroe, surveyor, and the actual work of the survey extending from St. Francisville to Canton embraced the time between October 21 and November 11. The maps of the Mississippi River Commission gave us abundant points to check both levels and alignment, and our map was plotted first on a scale of 1:10,000 and then reduced to a scale of 1:20,000 and compared with the Commission map, the agreement being excellent and furnishing a test of the accuracy of the survey. In filling out the details of the map it seemed to me best to show both sides of the river and all existing levees, from which a better idea of the problem and of the enormous contraction the construction of these levees will cause can be obtained.

On the map all lines actually run are indicated by station numbers marked in red figures. Proposed levees which were not projected until after the completion of the survey and map are indicated in broad red lines. The profile of these projected portions, where the line was not actually run, is an approximation only, but sufficiently accurate, I think, for the purpose of an initial estimate. The high-water slopes and the crown of the levee were placed at the same height as at opposite points on the east side of the river, the grade being 3 feet above high water of 1892. It was found difficult on the west side to obtain a sufficient number of accurate high-water marks, and the very careful determination made on the east side, where the water lines were abundantly shown upon the levee itself at very short distances apart, was considered better than the use of the scattering high-water marks which were found between Alexandria and Canton. The slope of the river was so well determined on the Warsaw-Quincy Levee that it was thought unnecessary to attempt to improve it.

The profile shows a continuous line from St. Francisville, on the Des Moines River, to near Canton, on the Mississippi, and the various side lines run up the tributaries flowing into the Mississippi between Alexandria and Canton. It was not found practicable, with the means at disposal, to run lines on both sides of all these streams. It can be assumed, however, without any material error, that the banks average equally high on both sides, and that the expense of a levee on one side would be about duplicated on the other. The tract of land affected by these levees is bounded on the east by the Mississippi River, on the north by the Des Moines River, and on the west by the bluffs of the Mississippi Valley, making a triangular area of land measuring in its widest part 6¼ miles and extending from Alexandria to Canton, a distance of 11¼ miles. It is an area of unsurpassed fertility and of inexhaustible soil; the ground is very flat and well cultivated, and the cornfields are almost continuous all over its extent. The Fox River, a stream of considerable size in times of freshets, divides this triangle into two unequal parts, and enters the Mississippi in two mouths (or did in former times), one within one-half mile of Alexandria and the other just above Gregory, Mo. The railroad company, in constructing its line from Keokuk to St. Louis, built an embankment across the upper mouth, so that the discharge is now entirely by the lower mouth, near Gregory. Long ago the continual freshets of the Fox and the Des Moines rivers led to the construction of levees along these streams, and also to some small attempts along Honey and Sugar creeks and the Mississippi River front in the vicinity of Gregory.

The value of the land for farming purposes well justifies these levees, and in a portion of the area, at least, the levees have been maintained by taxation on the lands benefited, under the laws of the State of Missouri. The farming lands are estimated as worth from $25 to $50 per acre, and 80 bushels of corn and 40 bushels of wheat are not unusual crops. The great drawback to the land is its extreme flatness. Like most alluvial bottoms, the land is highest on the margin of the streams, and when they get out of their banks and overflow the wide areas, which are very slowly drained off, they cause great destruction of property. An adequate system of levees which would protect these lands from overflow would no doubt add from $20 to $30 per acre to their value.

In considering the problem of leveeing these bottoms it must be borne in mind that there is no suitable defense against the Mississippi River unless the levees are closed at the lower end. On the Lower Mississippi it is possible and customary to leave the lower end of the district open, which permits all the surface water to drain off as rapidly as possible, and in floods only a comparatively small portion of the district is affected by backwater. In the present case the districts are so short and the slopes so flat that so soon as the river gets over its banks it inundates a great part and at very high water covers the whole area, and there would be no protection at all unless the levees were made continuous. In this case the matter of adequate drainage becomes of importance. If large and efficient outlets are not made the rainfall alone is sufficient, when hindered from flowing off, to submerge large portions of the districts. Within the past few days we have had a rainfall of 5 inches in forty-eight hours, and it can easily be seen that with a closed levee about this land it would be submerged for a long time by such a rainfall if there were not very large outlets made for the drainage water.

On the Warsaw-Quincy levee they have had six 48-inch pipes at the lower end of the Lima Lake district for several years, and have found them inadequate to carry off the water. They have recently added four more pipes of the same size, making ten in all, and even with this increased area of outlet it is entirely too small to save the lower end of the district from inundation in times of prolonged wet weather.

I have considered it advisable to separate the upper district, cut off by Fox River, from the lower end, calling one the Egyptian levee district, and the other Gregory district, and to treat them separately.

Egyptian levee district.—This district, between the Fox and the Des Moines rivers, is the more valuable of the two. It was the first settled and is the most cultivated. The so-called Egyptian levee protects it from the floods of the Des Moines River, and the levee on the north side of the Fox River protects it from the Fox. These levees are of good dimensions, and, in the opinion of the inhabitants and landowners with whom I have conversed, are sufficient for their purpose and can be maintained by their system of taxation, provided the Egyptian levee is protected against the erosion of the banks of the Des Moines River. Both of these levees were built under the laws of the State of Missouri, and are maintained by taxation.

The Egyptian levee is about 9¼ miles long, and extends from St. Francisville to Alexandria. As will be seen on the map, the Des Moines River at each bend has in time past encroached upon the levee and destroyed it, and the portions of abandoned levee, with the newer constructions farther back, are plainly shown. The Des Moines River is a rapid stream, with a much greater slope than the Upper Mississippi, and with banks of a more yielding nature. The map shows in dotted lines the position of the river bank when the old Government land survey was made. To give stability to the bed of the Des Moines River seems to be the simplest way of protecting the Egyptian levee, and this means riprapping the shore of each bend where it approaches the levee.

The language of the act providing for these surveys is such, however, that it was thought best to project the levee as far down as Canton, in order to satisfy any doubt as to what was actually meant. It will be seen that adopting the grades of the levee (3 feet above high water of 1892) on the east side of the river, it will be necessary to rebuild and strengthen about 1¼ miles of the Egyptian levee and to build a new levee from Alexandria to some point below.

I am satisfied, after studying the matter, that if we are to prevent the Fox River from overflowing its banks the simplest and least expensive method will be to divert it from its present course and let it discharge at its upper mouth, near Alexandria. This will vastly reduce the amount of levee and cross levee necessary to keep the river within bounds, and will furnish a better outlet in time than the present one, shortening its length several miles, and consequently giving it a steeper slope.

I have projected the crest of the levee on a level line from the Mississippi to intersect with the levees of the Fox and Des Moines rivers already existing. These levees seem to be sufficiently high and strong to restrain the floods which obtain on these streams. These floods last only a few days at a time, and are quite different in their effect and in the means required to withstand them, from the prolonged floods of the Mississippi, which cause the levees to become rotten and water-soaked, and they should consequently be given the greater cross section. I consider that the available means are sufficient to maintain the side levees as they have been maintained heretofore, and my estimate is based on this assumption.

The city of Alexandria, it will be seen by inspection of the map, is in a position to be flooded should the Des Moines levee break, and also, though in a lesser degree, in case of a break in the Fox River levee in the western part of the district. The embankment of the Keokuk and Western Railway, although it has 16 trestles in it, so confines the water when a break in the levee occurs on the Des Moines River side that the water rushes into Alexandria and floods the town; and it is feared that, if a levee is built connecting the Egyptian and Fox River levees, the floods will be increased unless liberal provision is made for the escape of water. Accordingly, I have provided in my estimate for an outlet 42 feet wide by 6 feet high, to be built of masonry or iron, and I do not think it will be too large. The area of the Egyptian levee district is 11,000 acres.

Gregory district.—This district, extending from the upper mouth of the Fox River to near Canton, is similar in character and in the disposition of the ground to the Egyptian district. It is, however, traversed by Honey Creek and Sugar Creek, both of which in times of flood carry considerable water, although far less than the Fox River. If the plan of diverting Fox River and causing it to discharge by the old upper mouth is carried out, we will have to remove the railroad embankment which crosses the former upper channel of Fox River and build in its place a bridge, besides moving or rebuilding the wagon bridge across Fox River.

The area of the district is 21,500 acres, and the value of the land is but little less than that in the Egyptian levee district. So far as I can learn, the levees in this district have been built with private means. Those on the south side of Fox River and on the two creeks mentioned are not so large nor so well constructed as those in the Egyptian levee district, and are built with the idea of protecting private ground and not located in many cases with judgment or with regard to permanency. There are about 1¼ miles of levee extending from Gregory southward, which was built at the expense of one man. This is a fairly good levee, although its grades are very uneven. It is built about 80 feet back from the river, and is, in this particular case, safe enough, as nearly the whole length of it is defended by a riprap shore protection put in by the United States for the regulation of the Mississippi River. Our line, as a rule, was kept back about 250 feet from the river. At the village of Gregory the river bank is now so near the houses that there is little room for a levee, excepting on the extreme verge of the river, unless we go back of the town and leave the houses unprotected. Our estimate is for a levee back of the town, but it will not cost any more to put it on the river bank.

The railroad embankment in both of these districts is too low to serve as a levee. Being submerged at high water, and being composed largely of loose rock, it is unfit for levee purposes. It does not seem worth while, therefore, to attempt to use any part of this embankment for a levee. It would be very expensive to attempt to raise the track and make the levee water-tight, and hence its use has not been considered.

The survey was stopped at a point about 4 miles above Canton, as the bluffs at that point are so near the river that a levee was not considered necessary.

The treatment of Honey and Sugar creeks is a problem. The original line of survey shows that Honey Creek formerly ran through the center of the district and drained off in the slough behind Tully Island. The levees built in recent years have cut off this water and diverted it into Sugar Creek, the two together flowing into Fox River after uniting. To provide for the drainage of these streams, my plan contemplates a large outlet at the present mouth of Fox River, which will no longer be occupied by that river, and the bed, from 150 feet to 300 feet wide, will form a reservoir for equalizing the flow of water and allowing it to escape by the outlet before damage is done. Of course, when the Mississippi is high, this water will seek an outlet at the south. A similar outlet is contemplated at the end of the district, near the head of Tully Island. All three outlets—that is, the one in the Egyptian Levee district and the two in this district—are proposed of the same dimensions, namely, 252 square feet of area.

It is probable that the interpretation of the law of Congress is satisfied by the survey and plan extending from Fox River Levee around to the Egyptian Levee.

This restricts very much the amount of work contemplated and will improve the Egyptian Levee district alone.

No estimate is made for land damages. It is presumed that the land will be donated, although it is a question whether this will be done. I find a great diversity of opinion among the owners of the land along the bottoms, many holding that the damage from seepage and rainfall restrained by the levees from flowing off more than counteracts the benefit derived from the protection of the land against the occasional occurrence of high water. Farmers tell me that they lose about one crop in seven by high water from the Mississippi, and that the benefit to the land from the silt deposited more than compensates for the loss of an occasional crop. The June rise, which usually is the one most feared, does not always occur, and even when it does it frequently drains off in time to plant and mature some one of the many different crops for which the land is well adapted.

Where a new levee is to be built or old levees strengthened, estimates are made for a 4-foot crown and slopes of 1 in 3 and 1 in 2 on the river and land side of the levees, respectively.

Estimate for artificial bank to prevent overflow of west bank of Mississippi River at the Egyptian Levee and between Alexandria and Canton.

1. Egyptian Levee district:

23,506 cubic yards earthwork, repairing and strengthening Egyptian Levee, at 15 cents	$3,526
33,629 cubic yards earthwork in new levee from east end of Egyptian Levee to upper mouth of Fox River, at 15 cents	5,044
109,654 cubic yards earthwork, repairing Fox River Levee (north side) and building new levee to Mississippi River at upper mouth of the Fox River, at 15 cents	16,448
14,000 linear feet of shore protection on Des Moines River, at $2.50	35,000
Outlet sluice of masonry, openings 252 square feet	20,000
Engineering and contingencies, about 15 per cent	11,982
Total	92,000

2. Gregory district:

577,521 cubic yards earthwork, from upper mouth of Fox River to Canton, at 15 cents	$86,628
170,552 cubic yards earthwork, on south side of Fox River, repairing old levee and building new one, at 15 cents	25,583
15,000 cubic yards excavation in old bed of Fox River, at 15 cents	2,250
Two outlet sluices of masonry, 252 feet openings, one at Fox River, the other near Canton	40,000
Steel bridge for railroad at upper mouth of Fox River	10,000
Moving county bridge to new location	4,000
Engineering and contingencies, about 15 per cent	25,039
Total	193,500

Very respectfully,

M. MEIGS,
United States Civil Engineer.

Lieut. Col. W. R. KING,
Corps of Engineers, U. S. A.

X 11.

SURVEY OF WEST SIDE OF MISSISSIPPI RIVER FROM THE BLUFF ABOVE THE CITY OF FORT MADISON TO THE MOUTH OF SKUNK RIVER, IOWA, WITH A VIEW OF IMPROVING THE NAVIGATION BY PREVENTING THE OVERFLOW OF THE NATURAL AND ARTIFICIAL BANKS AND BY DEEPENING THE CHANNEL.

[Printed in House Doc. No. 148, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 29, 1896.

SIR: The river and harbor act of June 3, 1896, contains an appropriation for improving Mississippi River from St. Paul to the mouth of the

Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> On the west side of said river from the bluff above the city of Madison, Lee County, in the State of Iowa, along the west bank of said river to the mouth of Skunk River, in said Lee County, * * * with a view of improving the navigation by preventing the overflow of the natural and artificial banks and by deeping the channel.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report of December 23, 1896, with map,* by that officer, giving the results of the survey made during the month of November, 1896.

The project submitted by Colonel King contemplates the construction of levees about 18 miles long, and he estimates the cost at $135,635.

He states the advantages to be derived from the proposed levee as a protection to land subject to overflow, but is of opinion that the construction of such banks as proposed will not be of any benefit to navigation, and in this opinion I concur.

Attention is invited to Colonel King's suggestion that if this work is to be undertaken by the General Government the right of way should be donated to the United States.

Very respectfully, your obedient servant,

W. P. Craighill,
Brig. Gen., Chief of Engineers.

Hon. Daniel S. Lamont,
Secretary of War.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

United States Engineer Office,
Rock Island, Ill., December 23, 1896.

General: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for the improvement of the Mississippi River from St. Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated as follows:
>
> * * * On the west side of said river from the bluff above the city of Madison, Lee County, in the State of Iowa, along the west bank of said river to the mouth of Skunk River, in said Lee County, * * * with a view of improving the navigation by preventing the overflow of the natural and artificial banks and by deepening the channel.

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress in ordering this survey is that the Government desires an estimate of the cost of preventing the overflow of the west bank of the river between the points named by the erection of artificial banks where needed.

This survey was made during the month of November, 1896, by a small party in charge of Assistant Engineer C. W. Durham, assisted by Inspector E. E. Barrett and a portion of the crew of the U. S. snag boat *General Barnard.*

Transit and level lines were run from a point above high water, at the foot of the bluffs on the south side of Skunk River, along the south bank of Skunk River to the Mississippi River; thence along the west bank of the Mississippi River to the bluffs about 2 miles above Fort Madison. The Skunk River line is 8 miles in length, and a cross levee for this distance is needed to accomplish the result desired.

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*Not reprinted. Printed in House Doc. No. 148, Fifty-Fourth Congress, second session.

A great number of bench marks were established, many high-water marks and water surfaces were taken, and calculations were made of the discharge of the various small creeks and sloughs to be crossed by the levees.

An earthen bank is proposed and estimated for, with a 4-foot width of crown, and a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered best for this part of the river, having been successfully used for many years in the Sny Island Levee and in the Warsaw to Quincy Levee. The grade of the top of the bank is placed at 3 feet above high water of 1888, which is the standard high water for this vicinity, it having been higher in that year than in any since 1851. The average height of artificial bank will be about 9 feet and its length 18 miles.

One drainage outlet will be necessary, at the mouth of Green Bay, and the probable cost of the necessary culvert pipes and masonry is included in the estimate.

It is suggested that, as in the case of the Flint Creek to Iowa River Levee (now in course of construction), right of way should be donated to the United States if this work is undertaken. Landowners have already built, here and there, small pieces of levee for their own special protection, but it is inadvisable, on account of their location, to use these old levees in building the new one.

The accompanying tracing gives the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. There are also on the tracing a detailed estimate of quantities and a small-scale map showing the river and country adjacent.

Estimate for artificial bank to prevent overflow of the west bank of the Mississippi River between Fort Madison and the Skunk River.

893,566 cubic yards earthwork, including engineering and contingencies, at 15 cents per cubic yard	$134,035
Drainage pipes at Green Bay, with valves and necessary stonework	1,600
Total	135,635

While I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, yet it may perhaps be of interest to submit some figures concerning the advantage to the land inclosed. The area of land which will be more or less benefited by the construction of the proposed levee is, approximately, 15,600 acres. A great part of this land is at present quite valuable, lying tolerably high and being partially protected by old levees; but it is thought that the appreciation which would result from the construction of a new and permanent levee would be, on an average, about $15 per acre, or $234,000.

Attention is invited to the fact that about 8 miles of the proposed levee is on the Skunk River, the construction of which appears necessary to prevent overflow of the entire area in question. It may be that at no distant day the improvement or protection of the banks of the Skunk River will become necessary to prevent undermining the levees.

This has occurred upon the Iowa River, and considerable expense has been involved in riprapping the banks of that stream to protect our levees.

Very respectfully, your obedient servant,

W. R. King,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. Craighill,
Chief of Engineers, U. S. A

X 12.

SURVEY OF WEST BANK OF MISSISSIPPI RIVER FROM MOUTH OF IOWA RIVER TO MUSCATINE, IOWA, WITH A VIEW OF IMPROVING THE NAVIGATION BY PREVENTING THE OVERFLOW OF THE NATURAL AND ARTIFICIAL BANKS AND BY DEEPENING THE CHANNEL.

[Printed in House Doc. No. 208, Fifty-fourth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, D. C., January 19, 1897.

Sir: The river and harbor act of June 3, 1896, contains an appropriation for improving the Mississippi River from St. Paul to the mouth of the Missouri River, and provides that out of this appropriation the Secretary of War shall cause certain surveys to be made, among which is the following:

> Along the west bank of the Mississippi River from the mouth of the Iowa River, in Louisa County, to the city of Muscatine, in Muscatine County, Iowa, with a view of improving the navigation by preventing the overflow of the natural and artificial banks and by deepening the channel.

The duty of making the survey thus provided for was assigned to the charge of Lieut. Col. W. R. King, Corps of Engineers, and I have now the honor to submit the accompanying copy of report, dated the 2d instant, with map,* by that officer, giving the results of the survey made during the months of September and October, 1896.

The project submitted by Colonel King contemplates the construction of a levee about 24½ miles long, and he estimates the cost at $139,800.

He states the advantages to be derived from the proposed levee as a protection to land subject to overflow, but is of opinion that the construction of such banks will not be of any benefit to navigation, and in this opinion I concur.

Attention is invited to Colonel King's suggestion that, if this work is to be undertaken by the General Government, right of way should be donated to the United States.

Very respectfully, your obedient servant,

W. P. Craighill,
Brig. Gen., Chief of Engineers.

Hon. Daniel S. Lamont,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 208, Fifty-fourth Congress, second session.

REPORT OF LIEUT. COL. W. R. KING, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Rock Island, Ill., January 2, 1897.

GENERAL: The river and harbor act of June 3, 1896, contains the following item:

> And the Secretary of War, out of the money herein appropriated and authorized to be expended for the improvement of the Mississippi River from St. Paul to the mouth of the Missouri River, shall cause surveys to be made and cost of improvements to be estimated, as follows:
>
> * * * Along the west bank of the Mississippi River from the mouth of the Iowa River, in Louisa County, to the city of Muscatine, in Muscatine County, Iowa, with a view of improving the navigation by preventing the overflow of the natural and artificial banks and by deepening the channel.

By letter of the Chief of Engineers, dated June 17, 1896, this survey was assigned to me. My understanding of the intentions of Congress in ordering this survey is that the Government desires an estimate of the cost of preventing the overflow of the west bank of the river between the points named by the erection of artificial banks where needed.

The survey was made during the months of September and October, 1896, by a small party in charge of Assistant Engineer C. W. Durham, assisted by Inspector E. E. Barrett and a portion of the crew of the U. S. snag boat *General Barnard*.

Transit and level lines were run from a point above high water just outside of the corporation limits of Muscatine, along the western and southern limits of the city, to the Mississippi River; thence along the west bank of the river to the mouth of the Iowa River, and along the north bank of the Iowa River to a point above high water at the foot of the bluffs near Toolsboro. An old levee, built by the property owners, runs from South Muscatine to Port Louisa. This was followed closely, and the estimate covers the cost of enlarging and raising the old embankment wherever it seems advantageous to use it.

A great number of bench marks were established, many high-water marks and water surfaces were taken, and calculations were made of the discharge of the various small creeks and sloughs to be crossed by the levee.

An earthen bank is proposed and estimated for, with a 4-foot width of crown and a slope of 3 to 1 on the river side and 2 to 1 on the land side, these dimensions being considered best for this part of the river, having been successfully used for many years in the Sny Island Levee and in the Warsaw to Quincy Levee. The grade of the top of the bank is placed at 3 feet above high water of 1892, which is the standard high water for this vicinity, it having been higher in that year than in any since 1851. The length of this levee will be about 24½ miles.

One drainage outlet will be necessary at the mouth of Muscatine Slough, a short distance above the Iowa River. Another outlet, in vicinity of Port Louisa, has already been provided by the builders of the old levee. The probable cost of the necessary culvert pipes and masonry for the outlet at the foot of Muscatine Slough is included in the estimate.

It is suggested that, as is the case of the Flint Creek to Iowa River Levee (now in course of construction), right of way should be donated to the United States if this work is undertaken.

The accompanying tracing gives the located line in plan and profile, with sufficient topography, bench marks, grade elevations, high-water marks, etc., for a full understanding of the subject. There are also on the tracing a detailed estimate of quantities and a small scale map showing the river and country adjacent.

Estimate for artificial bank to prevent overflow of the west bank of the Mississippi River from the Iowa River to Muscatine.

915,997 cubic yards earthwork, including engineering and contingencies, at 15 cents per cubic yard	$137,400
Drainage pipes, with valves and necessary stonework	2,400
Total	139,800

While I am not of the opinion that the construction of such banks as are herein proposed will be of any benefit to navigation, yet it may perhaps be of interest to submit some figures concerning the advantage to the land inclosed. Between Muscatine and Port Louisa there are 22,000 acres partially protected by the existing levee, which withstands all but very high stages of the river. This land is now worth probably $15 per acre, on an average, and the raising and strengthening of this levee so as to insure full and permanent protection against floods would probably increase its value about $15 per acre, or $330,000.

Between Port Louisa and the Iowa River there is no levee at present, and an entirely new one will have to be built. In this section there are only 6,000 acres of land to be benefited, but the appreciation in this case will be from $2 to $25 per acre, or $138,000. The total benefit, therefore, to land in both sections will be about $468,000.

Attention is invited to the fact that the lower 10 miles of the proposed levee, from Port Louisa to and up the Iowa River, will inclose only 6,000 acres of land, but will require about 539,000 cubic yards of embankment, which will cost, with the necessary outlet culverts, about $83,000. The upper 15 miles, incorporating the old levee, will benefit 22,000 acres of land and will cost about $57,000. About 2 miles of the lower end is on the Iowa River, which may cause trouble and expense from caving banks.

Very respectfully, your obedient servant,

W. R. King,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. Craighill,
Chief of Engineers, U. S. A.

APPENDIX Y.

CONSTRUCTION OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER; IMPROVEMENT OF RIVERS IN WISCONSIN AND MINNESOTA TRIBUTARY TO MISSISSIPPI RIVER, AND OF RED RIVER OF THE NORTH, MINNESOTA AND NORTH DAKOTA; GAUGING MISSISSIPPI RIVER AT ST. PAUL.

REPORT OF LIEUT. COL. W. A. JONES, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Construction of reservoirs at head waters of Mississippi River.
2. Operating and care of reservoirs at head waters of Mississippi River.
3. Chippewa River, including Yellow Banks, Wisconsin.
4. St. Croix River, Wisconsin and Minnesota.
5. Minnesota River, Minnesota.
6. Red River of the North, Minnesota and North Dakota.
7. Gauging Mississippi River at or near St. Paul, Minnesota.

EXAMINATIONS.

8. Mille Lacs Lake, Minnesota.
9. Otter Tail Lake and Otter Tail River, Minnesota.
10. Red Lake and Red Lake River, Minnesota.

United States Engineer Office,
St. Paul, Minn., July 15, 1897.

General: I have the honor to transmit herewith reports upon the works for improvement of rivers in my charge for the fiscal year ending June 30, 1897.

* * * * * * *

Very respectfully, your obedient servant,

W. A. Jones,
Lieut. Col., Corps of Engineers.

Brig. Gen. John M. Wilson,
Chief of Engineers, U. S. A.

Y 1.

CONSTRUCTION OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The reservoir project is the outcome of surveys and examinations in 1869, 1874, 1878, and 1879, the results of which are published in appendixes to various annual reports of the Chief of Engineers. The résumé of the subject is given in the report of the Board of Engineers, printed in Appendix A A to the Annual Report of the Chief of Engineers for 1887.

From the results of the surveys and examinations just noted, and further examinations in 1880, the first cost of constructing forty-one reservoir dams in Minnesota and Wisconsin was placed at $1,809,083.50, exclusive of that of land damages, which could not be given in advance. (See p. 1781, Appendix W to the Report of the Chief of Engineers for 1881.)

The project for this improvement was inaugurated in 1880 by an appropriation for the construction of a reservoir dam at Lake Winnibigoshish, made by act of Congress approved June 14, that year. For the reasons given in the Annual Report for 1886 the work of construction was commenced and has been continued in Minnesota.

The project has for its object the construction and maintenance of reservoirs at the head waters of the Mississippi River, in the State of Minnesota, for the purpose of collecting the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

There are five completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883–84; capacity, 45,024,000,000 cubic feet.

At Leech Lake, completed in 1884; capacity, 33,094,000,000 cubic feet.

At Pokegama Falls, completed in 1884; lift of dam increased in 1889; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; capacity, 7,500,000,000 cubic feet.

At Sandy Lake, completed in 1895; capacity, 3,158,000,000 cubic feet.

The construction of a sixth reservoir at Gull Lake, Minnesota, has been authorized.

Rules and regulations controlling the use and administration of the reservoirs were approved by the Secretary of War February 21, 1889, and printed on pages 1830 and 1831, Appendix Y, Annual Report, 1896.

The cost of the reservoir system at head waters of the Mississippi River has been $8.78 per million cubic feet storage capacity. This includes the whole cost of maintenance and repairs up to June 30, 1896. For a comparison of cost the following table has been prepared from figures given in the report of the State engineer and surveyor, State of New York, 1895.

Cost of reservoir systems.

	Storage capacity (in million feet).	Cost per million cubic feet.
Bear Valley Reservoir, California	1,766	$121.67
Bhatgur Reservoir, India	5,510	73.46
Long Valley Reservoir, California	1,433	50.73
Erkuk Reservoir, India	3,315	91.83
Sweetwater Reservoir, California	784	938.70
Hemmet Valley Reservoir, California	6,111	299.16
Periar Reservoir, India	6,969	106.75
Betwa Reservoir, India	1,603	204.25
Genesee River Reservoir, New York	7,700	[a]311.69
Upper Hudson storage system, New York	41,593	[a]62.69

[a] Estimated.

Since February 1, 1895, the expense of the care and maintenance of the completed reservoirs has been paid out of the appropriation for "operating and care of canals and other works of navigation, indefinite," and forms the subject of a separate report, which is referred to for a statement of the effect of the reservoir water upon the Mississippi River at St. Paul.

Amount expended to June 30, 1896, including outstanding liabilities, $820,311.59.

OPERATIONS DURING THE PAST FISCAL YEAR.

Pokegama Falls Reservoir.—An application was pending a year ago before the United States district court for the condemnation of 4.71 acres of land at both ends of the dam. The commissioners, appointed by the court, made an award of $6,517.50, which was considered so exorbitant that the Engineer Department recommended the dismissal of further proceedings. One of the defendants has objected to the motion for dismissal and has asked for judgment against the United States for the amount awarded him by the commissioners. Both motions will be argued July 13 next.

The machinery of the dismantled steamer *General Poe*, belonging to the appropriation Red River of the North, Minnesota and Dakota, was transferred to reservoirs at head waters of Mississippi River. A new hull was built at Pokegama during the past winter and the new steamer *General Poe* placed in commission April 21, 1897. The boat will operate between Pokegama Falls and Leech Lake and Lake Winnibigoshish, carrying supplies and maintaining communications between the reservoirs.

The Pokegama reservoir has not capacity sufficient to carry the water from its own watershed in addition to that which comes in from leakage and other causes from the two reservoirs above. Subsidiary reservoir at Deer and Bass lakes would afford considerable relief, and a survey is recommended to determine the cost. Also the capacity of Pokegama Lake can be considerably increased by dredging a deeper channel between it and the river. The machinery for a dredge is on hand, and it will only be necessary to construct a hull in order to have a sufficient plant for this work. The cost of survey will be $500. Cost of dredge hull, $2,000; three months operating expenses of dredge, $4,500.

Gull Lake Reservoir.—The restriction contained in the river and harbor act of August 17, 1897, "that the United States shall not be subject to any cost or expense for lands, mills, or other property necessarily taken or injured" in the construction of this reservoir, has delayed the commencement of the work. The sundry civil act approved June 4, 1897, contained the item:

> A sum not exceeding fifteen thousand dollars, or so much thereof as may be necessary, of the money heretofore appropriated for the construction of reservoirs at the headwaters of the Mississippi River may be used and is hereby made available for the payment of damages for lands and tenements overflowed or injured by the construction of a reservoir and dam at Gull Lake, Minnesota.

Preparations are being made to negotiate with land owners.

The present project is for a reservoir with a capacity of 2,712,000,000 cubic feet by the construction of ditches connecting Gull, Round, and Long lakes, and a timber dam at outlet of Gull Lake at an estimated cost of $85,000, including land damages.

During the past year examinations and surveys have been made to determine the cost and practicability of increasing the capacity of Gull Lake Reservoir to 12,500,000,000 cubic feet—the reservoir to be filled by diverting surplus water from the Crow Wing River into Gull and tributary lakes. This scheme involves the construction of a dam in the Crow Wing River, a canal from that point to the southern extremity of Sylvan Lake. Easy communication can be had between the north end of the latter lake and Gull Lake.

Pine River Reservoir.—The survey for this reservoir was made in 1880, but the funds available for the purpose were inadequate for an accurate and close determination of the flowage line. Preparations have been made for placing a party in the field July 1 to resurvey the south side of the reservoir.

A recent examination shows that three dikes are required in order there may be no escape of water when the reservoir is full. The estimated cost of the dike is $10,000.

Examinations in Upper Crow Wing River Basin.—In addition to the surveys on lower Crow Wing and Gull Lake an examination was made by T. M. Fowble, surveyor, for a possible reservoir site on the upper Crow Wing. Mr. Fowble's report is appended,* and reference is made to it for a description of the region. The examination disclosed that a reservoir with a capacity of 6,753,000,000 cubic feet may be created by constructing a dam 22 feet high 1 mile below the Shell River. It is not deemed wise to submit a complete report upon a reservoir in this locality until after a thorough survey has been made. With a view to controlling as much possible of the run off from the Crow Wing watershed, the most productive of any in the Upper Mississippi system, the survey will include the country about Lake Carlos and above, and also the lakes near the headwaters of other tributaries lying to the north. There is no single locality where the large quantity of water discharged from this watershed can be held. This makes it necessary to resort to a number of small reservoirs in addition to the large one at Gull Lake. A survey will cost $10,000.

Hydrological observations in the Mississippi River Valley above St. Paul.—Continuous hydrological records have been kept at the reservoir dams since the completion of each structure, and for several years past volumetric measurements of the river at St. Paul have been made under an allotment for "gauging the Mississippi River at or near St. Paul." These latter measurements form the subject of a separate report.

To supplement the records, two additional parties were placed in the field last September for a period of one year, the object being to obtain more precise information as to the effect of the reservoir water upon the river at St. Paul.

Party No. 1 is located at mouth of Crow Wing River. They measure the Mississippi, Crow Wing, and Gull rivers. Party No. 2 is located at Anoka. They measure the Mississippi, Rum, Crow, and Elk rivers.

The results of the measurements and the conclusion arrived at will be prepared after one year's observations have been made, and will be submitted with the next Annual Report.

A continuation of the hydrological measurements for two or three years longer is desirable. The expense is $5,000 per year.

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* Omitted.

Amount expended during fiscal year ending June 30, 1897, including outstanding liabilities, $13,593.91, divided as follows:

Pokegama Falls Reservoir:		
Building and furnishing steamboat	$3,439.87	
Land condemnation	39.23	
		$3,479.10
Gull Lake and Crow Wing River Basin: Surveys		2,665.04
Pine River Reservoir: Surveys		14.46
Hydrological expenses:		
St. Paul Station	$60.90	
Anoka Station	1,624.74	
Crow Wing Station	2,039.71	
General	482.24	
		4,207.68
Superintendence, contingencies, and St. Paul office expenses		3,227.63
Total		13,593.91

The estimate of money required is:

Gull Lake Reservoir: To complete Gull River Dam	$45,000
Pokegama Falls Reservoir: Dredging and survey	7,000
Pine River Reservoir: Dikes	10,000
Crow Wing watershed: Survey	10,000
Hydrological and meteorological measurements: Two years' observations	10,000
	82,000
Contingencies and engineering superintendence	8,000
Total	90,000

For commerce benefited by the reservoirs, reference must be made to the commercial statistics of the Mississippi River.

Abstract of appropriations.

By act—		By act—	
Approved June 14, 1880	$75,000	Approved September 19, 1890	$80,000
Approved March 3, 1881	150,000	Approved July 13, 1892	60,000
Passed August 2, 1882	300,000	Of August 17, 1894	51,000
Approved July 5, 1884	60,000	Passed June 3, 1896	80,000
Approved August 5, 1886	37,500		
Of August 11, 1888	12,000	Total	905,500

Money statement.

July 1, 1896, balance unexpended	$85,374.97
June 30, 1897, amount expended during fiscal year	13,328.58
July 1, 1897, balance unexpended	72,046.39
July 1, 1897, outstanding liabilities	451.89
July 1, 1897, balance available	71,594.50
Amount (estimated) required for completion of existing project	903,583.50
Amount that can be profitably expended in fiscal year ending June 30, 1899	90,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Y 2.

OPERATING AND CARE OF RESERVOIRS AT HEAD WATERS OF MISSISSIPPI RIVER.

The river and harbor act of August 17, 1894, made applicable to the reservoirs at head waters of the Mississippi River, "so far as concerns their care, preservation, and maintenance," the provisions of the general appropriation for "operating and care of canals and other works of navigation, indefinite," contained in section 4 of the river and harbor act of July 5, 1884. The first allotment was made January 25, 1895, and the expenses from February 1, 1895, have been paid from the indefinite appropriation.

There are five completed reservoirs, viz:

At Lake Winnibigoshish, completed in 1883-84; height of dam, 14 feet; capacity, 45,024,000,000 cubic feet.

At Leech Lake, completed in 1884; height of dam, 6 feet; capacity, 33,094,000,000 cubic feet.

At Pokegama Falls, completed in 1884; height of dam, 7 feet; increased in 1889 to 9 feet; capacity, 4,700,000,000 cubic feet.

At Pine River, completed in 1886; height of dam, 17 feet; capacity, 7,500,000,000 cubic feet.

At Sandy Lake, completed in 1895; height of dam, 9.4 feet; capacity, 3,158,000,000 cubic feet.

The location of the reservoirs is shown upon map printed opposite page 1844, Annual Report, 1896.

The maximum quantity of water held in the reservoirs at any one time since their completion was:

In Lake Winnibigoshish Reservoir, June, 1897, 28,727,442,893 cubic feet.
In Leech Lake Reservoir, June, 1897, 22,885,356,279 cubic feet.
In Pine River Reservoir, June, 1896, 5,700,000,000.
In Pokegama Falls Reservoir. This reservoir can be filled each year.
In Sandy Lake Reservoir. This reservoir can be filled each year.

The accident to the Pine River Reservoir that occurred last year prevented the collection of water in that reservoir during the past year. If the repairs could have been made last fall, the chances are that the reservoir would have been full at this date.

The purpose of the reservoirs is to collect the surplus water principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the dams and as far down as Lake Pepin. Reduction of heights of floods in localities immediately below the dams is expected to obtain to some extent, but control of extended floods or freshets is not expected.

EFFECT OF THE RESERVOIR WATER.

The effect of the reservoir water has been stated in previous annual reports with as great accuracy as the information at hand will warrant. The hydrological observations that are being made on this work, and also under the appropriations for reservoirs at head waters of Mississippi River and gauging Mississippi River at St. Paul, will, if continued for several years, give the facts necessary for a precise determination of the effect produced upon the river at and above St. Paul. It is, however, tolerably well established that the rise on the Signal Service gauge, St. Paul, due to reservoir water for ninety days during the low-water navigation period, has been from 12 to 18 inches.

CARE AND MAINTENANCE OF RESERVOIRS DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Sandy Lake Dam.—Minor repairs were made to the gates. The bank and bed of the river at foot of log sluice were riprapped.

Pokegama Falls Dam.—The dam was redecked and new timbers placed under the hoisting machinery of all the sluice gates.

On June 10 the Tainter gate, closing the log sluice, gave way. The pivot ends of the arms of the gate had rotted. The mishap in no way affected the operation of the dam or the controlling of the water. A new gate will be built in July.

The new steamboat *General Poe* was placed in commission April 21. The boat will be used in maintaining communication between the three upper reservoirs (Pokegama, Leech, and Winnibigoshish) and in carrying supplies.

Leech Lake Dam.—Repairs were made to the watchman's quarters and to the telephone line between this reservoir and that at Lake Winnibigoshish.

The dam was strengthened by raising it 2 feet and filling the additional space with rock. Materials used: 39,400 feet B. M. of timber and 310 cubic yards of rock.

This dam was built in 1884. Originally the timber portion was 1,000 feet in length. One year ago 405 feet were replaced by an earth embankment. The remaining 595 feet are weak and should be rebuilt. The dam was designed to hold a head of 6 feet on Leech Lake, but at present the safe limit is placed at 5 feet, and next year it may be considerably less. The expense of reconstructing the dam is estimated at $75,000.

Lake Winnibigoshish Dam.—The dam was redecked and two new booms were made for guiding logs and drifting bog into the sluices. Some difficulty has been experienced in protecting the earth embankment against the action of the waves. The riprapping of stone proved inadequate. The best protection was found to be timber booms floating on the water. Several lengths of boom were built for this purpose.

The Winnibigoshish Dam, as well as the Leech Lake Dam, was completed in 1884. Its condition is far from satisfactory. A full reservoir is 14 feet above low water of the lake, but this year the limit of safety was fixed at 10.80 on the gauge. The latter stage was reached May 23. Since then water has been wasted from the reservoir. The total wasted to June 30 has been 3,260,390,400 cubic feet. It is specially unfortunate that the dam is not in better shape, for the spring of 1897 has been the most favorable season for the collection of water since the reservoirs were built.

In view of the condition of the Leech Lake and Lake Winnibigoshish dams it was deemed advisable to station Assistant Engineer Archibald Johnson at those places since April 17 for the purpose of keeping a strict watch upon the dams. The timber portion of the Lake Winnibigoshish Dam should be replaced by new work at the earliest practicable date. The estimated cost of rebuilding is $150,000.

Pine River Dam.—The temporary brush and stone dam, to partially close the crevasse formed June 17, 1896, was completed in July, 1896. Total cost of temporary dam, $3,053.95.

The crevasse has been permanently closed by an earth dike at an expense of $9,747.24.

The dike was completed June 18, 1897. It is 380 feet long on top, 20 feet wide on top, with slopes of 1 vertical to 4⅜ horizontal. The dike was built 6 feet above the flowage line; the width at flowage line is therefore 96 feet. The height in deepest part is 29 feet. The material used was clean sand. No diaphragm or core was built. The sand was hauled by dump cars. The material placed this spring (about one-half of the entire quantity) was water packed, a pump having been erected for that purpose. The top and upper slopes of the dike is covered with a layer of peat. Timber booms floating on the water were built to protect the dike against wave action.

Total material in dike, 38,250 cubic yards.

Hydrological data.—The hydrological work of this Office furnishes the longest continued record over large drainage areas that has been made in the United States. A compilation of the observations to close fiscal year 1896 was printed on pages 1843 and 1862, Annual Report for 1896; also in this year's report on gauging the Mississippi River at or near St. Paul. The record for the reservoir dams is not published this year, though the data is on file in this Office. In next year's reports the tables will be corrected to close of the calendar year 1897.

Amount expended during the fiscal year ending June 30, 1897, including outstanding liabilities, $35,180.41, divided as follows:

Pokegama Falls Dam:		
Operating	$1,625.91	
Repairs	174.05	
Building telephone line	108.17	
Land condemnation	13.58	
		$1,921.71
Leech Lake Dam:		
Operating	1,306.80	
Repairs	1,146.00	
		2,452.80
Lake Winnibigoshish Dam:		
Operating	1,319.80	
Repairs	1,225.77	
		2,545.57
Pine River Dam and Reservoir:		
Operating	1,513.72	
Repairs to dam	133.38	
Completion of temporary brush and stone dam at crevasse	1,779.16	
Permanent dike at crevasse	9,747.24	
		13,173.50
Sandy Lake Dam:		
Operating	2,208.02	
Repairs	2,579.47	
Repairs, telephone line	7.50	
		4,794.99
Operating expense applicable to all reservoirs		3,419.56
Hydrological expense		3,034.64
Operating steamboat *General Poe*		612.46
Superintendence, contingencies, and St. Paul office expenses		3,225.18
Total		35,180.41

Estimate for the fiscal year ending June 30, 1898.

1 assistant engineer, 12 months, at $200	$2,400
1 watchman and head lock tender, 12 months, at $100	1,200
2 watchmen and dam tenders, 12 months, at $75	1,800
3 watchmen and dam tenders, 12 months, at $50	1,800
1 watchman and dam tender, 12 months, at $40	480
1 watchman and dam tender, 12 months, at $35	420
2 watchmen and dam tenders, 12 months, at $30	720
1 hydrographer, 12 months, at $90	1,080
1 hydrographer, 6 months, at $90	540

1 recorder, 12 months, at $90	$1,080
1 boatman, 12 months, at $45	540
1 master pilot, 6 months, at $35	210
1 fireman, 6 months, at $35	210
1 steamboat engineer, 6 months, at $50	300
1 cook, 6 months, at $35	210
Subsistence of 9 employees, 12 months, at $20 each	2,160
Subsistence of 6 employees, 6 months, at $20 each	720
Traveling expenses	500
Ordinary repairs to the Pokegama Falls, Sandy Lake, and Pine River reservoirs; repairs to lines of communication between the reservoirs; tools and instruments, and repairs to tools and instruments	5,000
Contingencies and St. Paul office expenses	2,500
Total	23,870

For commercial statistics reference must be made to the reports upon the improvement of the Mississippi.

Abstract of expenditure by fiscal years.

During fiscal year ending June 30, 1895	$6,416.19
During fiscal year ending June 30, 1896	30,800.15
During fiscal year ending June 30, 1897	35,180.41
Total	72,396.75

Abstract of allotments.

January 25, 1895	$17,590.00
June 15, 1895	18,852.91
June 20, 1896	5,000.00
July 24, 1896	23,471.98
For repairs to Pine River Reservoir	7,481.86
Total	72,396.75

Money statement.

July 1, 1896, balance unexpended	$8,936.07
Allotted July 24, 1896	23,471.98
Allotted for repairs to Pine River Reservoir	7,481.86
	39,889.91
June 30, 1897, amount expended during fiscal year	37,155.73
July 1, 1897, balance unexpended	2,734.18
July 1, 1897, outstanding liabilities	2,734.18

Itemized statement of expenditures during the fiscal year ending June 30, 1897.

Date.	To whom paid.	For what paid.	Amount.
1896.			
July 27	Sundry persons	Pay roll for July, Pine River.	$1,610.10
Aug. 1	.....do	Pay roll for July, office	205.00
4	M. Lavansky	Vegetables, etc	10.60
5	Sundry persons	Pay roll for July, Pine River.	54.13
	.....do	Pay roll for July, Pine River Dam.	80.00
	.....do	Pay roll for July, Sandy Lake	140.00
12	.....do	Pay roll, upper dams	504.00
	August Ostland	Ice and potatoes	4.20
	Line & Brooks	Groceries	21.23
	W. Potter & Co	Feed, etc	8.62
	Slipp Bros	Pike poles	12.50
14	Frank Curtis	Services	7.50
	Line & Brooks	Meats	4.49
	Archie Purdy	Team hire	12.00
19	Cross Lake Logging Co	Supplies, boats, etc	72.66

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1896.			
Aug. 19	H. H. Perrine	Traveling expenses ($17.85 less $8.10).	$9.75
	A. C. Gould	Teaming	10.00
	Lieut. Col. W. A. Jones	Mileage	16.00
21	Olaf Johnson	Services	6.67
	Cluft Bros	Transportation	109.41
	J. C. Millen	Paper	10.50
25	W. Potter & Co	Oakum and pitch	6.00
	G. W. Knox	Groceries	57.47
	H. E. Wedelstædt	Stationery	18.90
	E. A. Brown	Repair work	6.50
	Nichols & Dean	Iron	8.40
	Brown, Treacy & Co	Stationery	13.57
	Archibald Johnson	Traveling expenses	10.14
	Boeringer & Son	Repair work	1.85
	T. W. Ingersoll	Roll films	6.00
	Adams Express Co	Express charges	.70
	Northern Pacific Express Co	do	1.30
	Pioneer Press Co	Blanks	1.45
	North American Telegraph Co	Telegrams	1.12
	Mannheimer Bros	Tablecloth, etc	11.80
26	A. D. Brown	Repair work	2.20
	Adams Express Co	Express charges	.70
	H. S. Dowe	Meat, etc	9.87
	Western Supply Co	Pump paint	1.58
	St. Paul Hardware Co	Hardware	7.60
	Zimmerman Bros	Paper, etc	1.10
28	Lieut. Col. W. A. Jones	Mileage	16.00
31	Sundry persons	Pay roll for August	205.00
	Western Union Telegraph Co	Telegrams	3.01
Sept. 4, 7	Sundry persons	Pay roll for August	464.96
7	do	do	150.00
	Archibald Johnson	Services, pay roll for August	180.00
9	Sundry persons	Part pay roll for August	286.00
	do	Pay roll for August	110.00
18	James Butt	Hauling	19.26
	G. W. Knox	Rope, etc	106.48
	W. Potter & Co	Groceries	123.87
	Joseph Crowther	Hauling freight	10.31
	H. Rosenblatt	Rock, brush, etc	156.85
	Willis & Clements	Photo supplies	2.23
	Ryan Drug Co	Paints, oils, drugs, etc	12.82
	Brown Treacy & Co	Stationery	17.15
	Johann Luthi	Butter	12.00
	Griggs & Co	Groceries	232.93
	Marr & Krech	Steel	9.88
21	Lieut. Col. W. A. Jones	Mileage	16.00
22	do	do	23.96
24	Robinson, Cary & Co	Blocks, etc	11.93
	Electrical Engineering Co	Repair work	8.00
	Mannheimer Bros	Towels	13.00
25	S. & J. W. Koop	Brick	6.00
	Northern Pacific Railroad Co	Tickets	38.92
	Slipp Bros	Hardware	5.98
	G. W. Knox	Groceries	20.05
Oct. 1	Sundry persons	Pay roll for September	205.00
2	do	Pay roll, Sandy Lake	276.85
	Dan Lyons	Services	6.00
	North American Telegraph Co	Telegrams	3.47
	John Jackson	Team hire	5.92
	do	do	4.12
	J. M. Romans	Supplies	1.50
	Zimmerman Bros	Paste, etc	3.50
5	Lieut. Col. W. A. Jones	Mileage	13.44
6	Sundry persons	Pay roll for September	302.00
	do	do	276.00
	Koehler & Hinrichs	Scales	4.50
9	Sundry persons	Pay roll for September	147.17
	do	do	147.67
	James Butt	Freighting	2.27
10	Sundry persons	Part pay roll for October	36.00
9	Geo. Snetsinger	Traveling expenses	13.10
	Northern Pacific Express Co	Express charges	2.10
16	W. L. Wakefield	Meat	8.78
	Carbolineum Wood Preserving Co	Paint	40.80
	Western Union Telegraph Co	Telegrams	3.10
	Carbolineum Wood Preserving Co	Paint	124.00
	J. M. Romans	Hauling paint	1.50
	Johann Luthi	Butter	4.96
19	W. T. Hutchins	Part pay roll for October	27.00

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1896.			
Oct. 21	H. Rosenblatt	Rock, etc	$78.90
31	Sundry persons	Part pay roll for October	158.00
29	Peteler Portable Railway Manufacturing Co	Rails, cars, etc	548.36
	Robinson & Cary Co	Wheel scrapers	64.00
	Kent Nelson	Traveling expenses	1.40
	Sam. Sanborn	Hay	24.65
	Slipp Bros	Iron reservoir, etc	10.85
	Pioneer Press Co	Blanks	2.25
	Griggs Bros	Bags	1.00
	Boeringer & Son	Tape, etc	7.89
	Zimmerman Bros	Photo supplies	5.16
	Stevens & Robertson	Pens and books	1.30
	H. E. Wedelsteadt	Stationery	9.28
	do	do	30.85
30	Brainerd Lumber Co	Lumber	17.00
Nov. 13	John Driscoll	Teamster and team	16.00
	Sundry persons	Pay roll, upper dam	277.50
16	do	Pay roll, Pine River Crevasse	951.07
	Brainerd & Northern Rwy. Co	Transportation	54.19
	Sundry persons	Pay roll, Pine River Dam	290.00
17	do	Pay roll, Sandy Lake	142.66
	do	Pay roll, telephone line	29.15
19	do	Pay roll, Leech Lake	63.00
	do	Pay roll, Sandy Lake Dam repairs.	142.73
	John E. Dempsey	Notebooks	46.00
20, 30	Sundry persons	Gauging crews	218.00
27	W. A. Curo	Hauling freight	52.44
	do	do	6.04
	Archibald Johnson	Traveling expenses	45.37
	E. A. Brown	Timers, etc	52.00
	G. W. Knox	Groceries	53.74
	Peteler Portable Railway Manufacturing Co	Rails, switches, etc	84.26
	Slipp Bros	Pans, oilcloth, etc	2.87
	do	Horseshoes, etc	1.45
	do	Kitchen utensils	53.99
	do	Stoves, nails, etc	76.48
	do	Iron, coal, etc	38.25
	do	Iron and pails	7.85
	Archibald Johnson	Traveling expenses	10.37
	N. Dally	Hauling freight	20.00
	W. L. Wakefield	Groceries	1.77
	Cross L. Logging Co	Lumber, etc	8.57
	H. Rosenblatt	Brush, meat, etc	20.72
	Ben Hersey, jr., Co	Fruit, etc	2.45
	August Ostlund	Hay	16.00
	Adams Express Co	Express charges	.70
	Northern Pacific Express Co	do	6.45
	Brown, Treacy & Co	Stationery	6.85
	St. Croix Lumber Co	Lumber	1.81
	Hart Johnson	Onions	3.25
	W. Potter & Co	Ink	.50
	A. C. Gould	Vegetables	38.50
	do	Lumber	18.96
	do	Board	32.00
	do	Team	16.00
	Carbolineum Wood Preserving Co	Paint	126.40
	do	do	130.40
	Pioneer Press Co	Blanks	3.75
	Neil McKay	Team service	30.00
	do	Lumber	36.00
	North American Telegraph Co	Telegrams	2.56
	James Butt	Hauling freight	4.59
	do	Hauling	9.96
	Nicols & Dean	Drill, etc	21.60
	Finch, Van Slyck, Young & Co	Tents	67.80
	S. & J. W. Koop	Oats and feed	29.76
	P. P. Johnson	Hauling cars	2.50
	W. G. Moore	Lumber	69.86
	William Gordon	Fresh meat	37.02
	Lieut. Col. W. A. Jones	Mileage	29.58
	A. Purdy	Team hire	12.00
	Archie Purdy	Hauling freight	6.00
	Sam Sanborn	Hay	4.66
	A. C. Gould	Hauling freight	12.83
	do	do	31.32
Dec. 1	S. & J. W. Koop	Supplies	493.14
5	Sundry persons	Pay roll for November	1,060.50
	W. T. Hutchins	Traveling expenses	5.51
9	Sundry persons	Pay roll for November	290.00

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1896.			
Dec. 9	Sundry persons	Pay roll for November	$131.15
	....do	....do	276.00
10	....do	....do	428.50
15	....do	....do	150.00
	....do	....do	283.46
	H. H. Perrine	Traveling expenses	13.90
	R. S. Mayer	....do	9.40
	Geo. Snetsinger	....do	7.10
	Sundry persons	Pay roll for December	90.00
17	....do	....do	132.00
	W. A. Curo	Fresh meat	23.60
	G. W. Knox	Groceries, etc	56.68
	Neil McKay	Team hire	23.00
	Joseph Crowther	Steamboat hire	100.00
	Western Union Telegraph Co	Telegrams	6.85
18	W. R. Shaw	Shingles	34.00
23	Slipp Bros	Tarred felt	1.23
	W. J. & H. Powers	Nails	4.50
	St. Croix Lumber Co	Lumber	4.20
	M. J. Reilly	Groceries	8.54
	Mannheimer Bros	Blankets and muslin	61.10
	L. M. Koop	Bed ticks, etc	28.31
29	W. L. Wakefield	Meat, etc	3.15
	A. C. Gould	Teamster and team	14.00
	....do	....do	55.00
	H. Rosenblatt	Meat, etc	43.91
	....do	Meat	17.52
	....do	Hauling	10.00
	A. Mahlum	Services	3.00
	Archie Purdy	Team hire	12.00
	H. E. Wedelsteadt	Stationery	30.11
	Northern Pacific Express Co	Express charges	2.85
	Robinson & Cary Co	Hose, etc	19.78
31	Lieut. Col. W. A. Jones	Mileage	25.52
	Sundry Persons	Pay roll for December, office.	382.50
	....do	Part pay roll for December	125.00
1897.			
Jan. 8	Sundry persons	Pay roll for December, 1896.	309.07
	....do	....do	284.50
	L. B. Wilson	Services	9.00
13	Sundry persons	Pay roll for December, 1896.	142.33
14	....do	....do	424.00
20	J. W. Poole	Fresh meat	3.80
	J. F. Metzger	....do	4.25
	A. L. Cole & Co	Nails	9.00
	....do	Supplies	166.95
	J. E. Kimball	Meat	9.30
	Wm. B. Hale & Co	Batteries	3.00
	North American Telegraph Co	Telegrams	1.80
	Crescent Creamery Co	Butter	6.90
	Beckfelt & Mather	Merchandise	10.57
	W. J. & H. D. Powers	Hardware	20.67
21	St. Croix Lumber Co	Windows, etc	60.36
	W. V. Fuller & Co	Lumber	33.60
	Marr & Krech	Oak and steel, etc	86.00
	H. Rosenblatt	Hay	30.00
22	Boeringer & Son	Repair work	2.25
	Robinson & Cary Co	Screw plate	29.52
	G. W. Knox	Oil	2.00
	Adams Express Co	Express charges	1.20
	Northwest Engineering Co	Battery	1.00
26	Henry J. Green	Hygrometers	16.20
27	United States Express Co	Express charges	1.15
	James Butt	Hauling	9.39
	Pioneer Press Co	Subscription	3.00
	Ryan Drug Co	Paint, etc	6.20
	St. Paul Hardware Co	Hardware	37.21
30	Sundry persons	Pay roll for January	215.00
Feb. 5	....do	Pay roll for January, Pine River.	136.00
	....do	Pay roll for January, Upper Dam.	535.93
8	....do	Pay roll for January, Leach Lake Dam.	419.67
12	....do	Pay roll for January, Sandy Lake Dam.	140.00
16	Sam V. Morris	Services	75.00
	Western Union Telegraph Co	Telegrams	3.02
18	Jas. A. Quigg	Meals and lodgings	2.75
	Brainerd & Northern Minnesota Rwy. Co	Transportation	9.44

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1897.			
Feb. 18	Brainerd & Northern Minnesota Rwy. Co	Transportation	$11.56
	F. E. Mesing	Rubberstamps	1.20
	Frank N. Allen	Hauling freight	5.60
	Levi Lyon	Wood	17.94
	Crescent Creamery Co	Butter	96.00
	Griggs Bros	Oats and corn	19.99
	Brown, Treacy & Co	Stationery	9.00
	J. F. Metzger	Fresh meat	23.30
19	W. L. Wakefield	Hauling	8.36
	Michaud Bros	Groceries	149.47
	Ogden, Merrill & Greer	Crockery	4.44
	Robinson & Cary Co	Fixtures	3.35
	A. D. Brooks & Co	Hauling supplies	5.00
	Beckfelt & Mather	Table cloth, etc	3.00
	W. J. & H. D. Powers	Cook stove, etc	31.10
	St. Paul Hardware Co	Castings	1.25
	L. F. Knox	Lumber	18.26
	Geo. Snetsinger	Traveling expenses	24.45
	H. H. Perrine	do	22.20
26	McQuillian Bros	Job work	100.00
	Minnesota Engine Works	Repair work	10.25
Mar. 1	Sundry persons	Pay roll for February, office.	665.00
	do	Pay roll for February, gauging crew.	215.00
1, 9	do	Pay roll for February, Upper Dams.	506.00
2	H. H. Perrine	Services	90.00
9	Sundry persons	Pay roll for February, Sandy Lake.	140.00
	do	Pay roll for February, Pine River.	136.00
10	W. V. Fuller & Co	Lumber	143.20
	J. M. Romans	Hauling freight	3.75
	Frank N. Allen	do	7.94
	H. M. Smyth Printing Co	Blanks	4.50
	Michaud Bros	Groceries	57.37
	R. C. Libbey & Co	Lumber	8.00
	W. J. & H. D. Powers	Hardware	25.49
	Stone, Ordean, Wells & Co	Oil	16.50
	Bergmeier & Co	Stationery	3.70
15	Lieut. Col. W. A. Jones	Mileage	19.44
	Wells Stone Mercantile Co	Groceries	236.61
	Griggs & Co	Candles, etc	3.25
	Itasca Mercantile Co	Subsistence	91.84
	Board Water Commissioners	Water	8.00
17	W. B. Hale & Co	Carbons, etc	2.35
	Western Union Telegraph Co	Telegrams	1.10
	Boeringer & Son	Repair work	1.75
	Geo. J. Grant	Lumber, etc	120.15
	Frank Clifton	Beef, etc	87.49
	Zimmerman Bros	Paste trays, etc	5.45
18	Cluff Bros	Team hire	12.00
	Levi Lyons	Wood	42.00
23	Sundry persons	Pay roll for February, Winnibigoshish.	354.00
	Robinson & Cary Co	Gasoline burners, etc	20.41
	N. W. Engineering Co	Okonite, etc	27.65
	Stevens & Robertson	Pens, etc	1.00
	North American Telegraph Co	Telegrams	1.84
25	A. D. Brooks & Co	Meat, etc	26.85
	J. F. Metzger	Beef	8.24
29	Adams Express Co	Express charges	4.60
	Mannheimer Bros	Iron beds, etc	19.63
31	Sundry persons	Pay roll for March, gauging crew.	215.00
	H. H. Perrine	Services	90.00
Apr. 1	Lieut. Col. W. A. Jones	Mileage	25.52
2	Sundry persons	Pay roll for March	304.00
	Robt. A. Smith, postmaster	Post-office box rent	1.50
5	Sundry persons	Pay roll for March	555.80
	do	do	136.00
7	do	do	22.50
	John W. Poole	Vegetables	6.75
	E. A. Brown	Repair work	5.00
	Duluth, Superior and Western Rwy. Co	Ticket	6.16
	Adams Express Co	Express charges	4.25
	St. Paul Gaslight Co	Gas	2.21
	Eugene Libby	Hay	13.50
	J. C. Jones	Wood	32.00
	J. F. Metzger	Tallow and fresh meat	22.05

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1897.			
Apr. 8	Lieut. Col. W. A. Jones	Mileage	$13.44
13	Sundry persons	Pay roll for March	175.00
	Frank Clifton	Sausage	4.75
	Robinson & Cary Co	Ash pan and rivets	26.70
	The Crane & Ordway Co	Pipe, etc	18.24
	W. J. & H. D. Powers	Snow gauges	2.25
	Beckfelt & Mather	Ink and snowshoes	4.15
16	H. Rosenblatt	Hauling	48.00
	M. Howley	Services	5.60
20	Geo. Snetsinger	Traveling expenses	25.30
	North American Telegraph Co	Telegrams	5.44
	James Butt	Hauling	8.07
	G. W. Knox	Feed	9.00
	Archie Purdy	Hauling	43.61
26	A. T. McGregor	Repair work	48.60
	Archie Purdy	Team hire	6.00
	Electrical Engineering Co	Transmitters	10.55
27	S. & J. W. Koop	Butter, lard, etc	12.84
30	Sundry persons	Pay roll for April	278.50
May 3	H. H. Perrine	Traveling expenses	13.25
4	Sundry persons	Pay roll for April	519.20
	....do	....do	758.83
7	Lieut. Col. W. A. Jones	Mileage	17.24
12	Sundry persons	Pay roll for April	110.00
	....do	....do	54.96
	....do	....do	29.25
	....do	....do	144.50
19	Pat. Calmine	Hay	14.00
	Chris. Boelm	Potatoes	3.00
	August Ostlund	....do	5.78
	A. C. Gould	Potatoes, turnips, etc	10.80
	Neil McKay	Use of team	20.00
	Geo. Snetsinger	Traveling expenses	11.00
	E. P. Wakefield	Team hire	52.00
	Sundry persons	Pay roll for April	8.00
	Griggs Bros	Burlaps	27.85
	Cross Lake Logging Co	Lumber and sauerkraut	33.00
	Michaud Bros	Groceries	66.11
	Arthur Hagberg	Sirup and butter	3.75
	....do	Supplies	223.65
	Robinson & Cary Co	Valves, oil, hose, etc	49.45
	Crescent Creamery Co	Butter	40.00
20	Minnesota Engine Works	Job work	23.57
	Geo. Cassada	Wood	15.00
	Archie Purdy	Hauling freight	7.99
	J. F. Metzger	Fresh meat	17.80
	M. F. Kennedy Bros	Oars	3.00
	Buff & Berger	Repair work	22.10
	Electrical Engineering Co	Dry batteries	11.52
	Slipp Bros	Hardware and crockery	3.54
	Beckfelt & Mather	Groceries, etc	9.73
26	L. L. May	Garden seed	4.35
	Mannheimer Bros	Dry goods	28.36
	Slipp Bros	Hardware	11.83
	North American Telegraph Co	Telegrams	6.86
	William Morse	Potatoes	4.65
	Ryan Drug Co	Paint, etc	31.94
	St. Paul Hardware Co	Hardware	4.66
31	Sundry persons	Pay roll for May	288.38
	H. E. Wedelsteadt	Stationery	115.21
June 1	Soren Denesen	Services	4.50
	T. Lund	....do	.75
	Chas. S. Hildreth	....do	12.00
	Henry Witherow	....do	24.50
3	Dan Lyons	....do	8.17
8	Sundry persons	Pay roll for May	1,319.50
	....do	....do	197.60
	....do	....do	539.00
	....do	....do	110.00
16	....do	....do	144.50
30	....do	Pay roll for May and June	42.75
	....do	Pay roll for June, office	920.00
16	H. E. Wedelsteadt	Stationery	42.56
	S. & J. W. Koop	Feed and oats	35.05
	Louis Poirier	Wood	72.00
	Beckfelt & Mather	Mess supplies	84.33
	W. & H. D. Powers	Hardware	38.02
	Neil McKay	Use of team	30.00
	Archibald Johnson	Traveling expenses	18.70

Itemized statement of expenditures during the fiscal year ending June 30, 1897—Continued.

Date.	To whom paid.	For what paid.	Amount.
1897.			
June 16	A. Ostlund	Use of team	$35.95
	M. J. Reilly	Feed and oats	35.91
	.....do	Supplies	187.24
	Northwest Telephone Exchange Co	Rent	5.00
	C. L. Maynard	Butter	15.40
	B. F. Symmes	Wood	15.00
	Adams Express Co	Express charges	2.40
	Western Union Telegraph Co	Telegrams	7.26
	North American Telegraph Co	.....do	2.40
	F. Peteler	Brakes, etc	24.80
25	Robinson & Cary Co	Machinery supplies, etc	55.85
	.....do	Dies, etc	12.12
	S. & J. W. Koop	Fresh meat	20.88
	Standard Oil Co	Oils	33.39
	Archie Purdy	Team hire	6.00
	W. T. & H. D. Powers	Rope	6.97
	W. B. Hale & Co	Zinc, etc	.50
	Smith & Riddle	Repairs	1.00
	A. C. Gould	Hay	9.80
	St. Paul Furniture Co	Repair work	4.90
	Slipp Bros	Hardware	8.59
	George Smith	Meat	1.52
	J. F. Metzger	Fresh meat	15.85
	M. F. Kennedy & Bros	Tent flys	41.00
	Kent Nelson	Traveling expenses	5.10
30	A. O. Powell	Emergency purchases	55.06
			32.210.41
June 30	Treasury settlements during year		235.82
	Total		32,446.23

Outstanding liabilities June 30, 1897.

To whom owing.	On account of—	Amount.
Sundry persons	Pay roll, Pine River, June	$993.92
Do	Pay roll, Pine River	213.88
Do	Pay Roll, Sandy Lake	141.50
R. A. Smith	Post-office box	1.50
R. Davenport	Travel expenses	2.30
Neil McKay	Use of team	21.00
Kuhlo & Ellerbe	Drawing materials	39.06
A. O. Powell	Emergency purchases	19.23
Do	.....do	22.95
A. T. Kimball	Use of team	20.00
A. Ostlund	.....do	20.00
Sundry persons	Pay roll, Pokegama Falls, June	747.50
G. W. Knox	Ink	.60
W. Potter & Co	Oilcloth	7.33
Boeringer & Son	Drawing materials	106.53
S. & J. W. Koop	Supplies	43.81
Do	Feed and oats	40.06
Thorp & Martin Co	Stationery	8.50
Archie Purdy	Use of team	6.00
Cross Lake Logging Co	Lumber, etc	83.25
Slipp Bros	Coal and iron	7.63
C. L. Maynard	Butter	9.80
D. M. Clark & Co	Hardware	39.15
Western Union Telegraph Co	Telegrams	11.90
North American Telegraph Co	.....do	4.10
Duluth, Superior and Western Rwy	Rental	10.66
A. Johnson	Travel expenses	5.25
St. Paul and Duluth Rwy	Tickets	26.20
Northern Pacific Rwy	.....do	6.55
Railroads	Unsettled freight accounts outstanding.	73.42
Total		2,734.18
Expended to June 30, 1897		32,446.23
Total		35,180.41

Y 3.

IMPROVEMENT OF CHIPPEWA RIVER, INCLUDING YELLOW BANKS, WISCONSIN.

The first examinations and surveys of this stream were made in 1874 and 1875. Based upon the latter, a project was prepared for the improvement, consisting of the revetment of caving banks and construction of dams and jetties from Eau Claire to the confluence of the stream with the Mississippi River, a distance of 56 miles, in order to confine the low-water volume to a channel of nearly uniform width; also to protect the five Yellow Banks bordering on the river. Object: To provide an open channel 200 feet wide and 3 feet deep, and relieve the channel of the Chippewa River and of the Mississippi River below the junction of the two streams from the sand contributed by the Yellow Banks. First estimate of cost, $139,892.50. The project has remained unaltered, except an increase in the amount of work to be done. The estimate has been revised three times. The last one (made in 1888) placed the cost at $272,487.72.

For a full description of the river and detailed statement of the revision of projects reference is made to pages 2183–2188, Appendix Y, Annual Report for 1895.

Before the improvement commenced the depth on the bars at low water seldom exceeded 18 inches, and the crossing at the mouth of the river was extremely difficult at that stage, owing to the volume of the river joining the Mississippi through a number of channels of insufficient depth. Frequently the depth of water on the bar at the mouth of the river was but 10 or 12 inches.

The work of improvement to June 30, 1895, has provided a permanent channel 3 feet deep over the bar at the mouth of the river, and materially increased the depths over the Durand, Plum Island, Plum Island Flats, Battle Island, Wacouta Island, and Flower Pot Island bars, besides straightening a difficult piece of river at the Madison Street Bridge, in Eau Claire, and the stoppage of a difficult and dangerous cut-off at Dead Lake. Where the improvements have been completed, the channels are 3 feet or more in depth. The channel improvements have effected a material reduction in the cost of running rafted lumber from Eau Claire to the mouth of the river.

No work of consequence has been done at the Yellow Banks since 1883, at which time about one-fifth of the banks had been revetted.

Total expended from commencement of operations in 1877 to June 30, 1896, including outstanding liabilities, $180,771.91.

Operations during the past fiscal year.—Field operations have been confined to repairs of Wacouta Island Dam No. 2. A good channel was maintained from July 1, 1896, to close of the season. Continuous high water since the ice went out in 1897 to close of present year has provided sufficient depth of water without the need of works of improvement. Several bars show indications of becoming troublesome before low water is reached. It is expected to work on them during the fall of 1897.

Mr. A. O. Powell, assistant engineer, has had local charge of the improvement of the river, as well as of the St. Croix River, in addition to duties as assistant engineer on all the works pertaining to this district.

Expenses during the fiscal year ending June 30, 1896, including outstanding liabilities, $3,115.28.

The sum of $80,737.72 can be profitably expended during the fiscal year ending June 30, 1899.

For channel improvements	$70,737.72
For survey	10,000.00
Total	80,737.72

This work is in the collection district of Milwaukee, Wis. The duties on imports collected during the year ending December 31, 1896, amounted to $329,398.87.

Abstract of appropriations.

By act—	
Approved August 14, 1876	$10,000
Approved June 8, 1878	10,000
Approved March 2, 1879	8,000
Approved June 14, 1880	10,000
Approved March 3, 1881	10,000
Passed August 2, 1882	65,000
Approved July 5, 1884	15,000
Approved August 5, 1886	18,750

By act—	
Of August 11, 1888	$10,000
Approved September 19, 1890	10,000
Approved July 13, 1892	5,000
Of August 17, 1894	10,000
Passed June 3, 1896	10,000
Total	191,750

Money statement.

July 1, 1896, balance unexpended	$11,003.09
June 30, 1897, amount expended during fiscal year	3,112.66
July 1, 1897, balance unexpended	7,890.43
July 1, 1897, outstanding liabilities	27.62
July 1, 1897, balance available	7,862.81
Amount (estimated) required for completion of existing project	80,737.72
Amount that can be profitably expended in fiscal year ending June 30, 1899	80,737.72

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

COMMERCIAL STATISTICS.

Comparative statement of lumber, laths, shingles, pickets, and logs.

Year.	Lumber.	Laths.	Shingles.	Pickets.	Total tonnage exclusive of loose logs.	Loose logs.
	Feet B. M.	*Number.*	*Number.*	*Number.*	*Tons.*	*Feet B. M.*
1878	154,119,860	40,000,000	125,000,000	10,000,000	....	Unknown.
1879	248,932,000	62,044,000	135,152,000	12,000,000	....	250,000,000
1880	325,150,000	100,357,750	74,945,150	2,423,940	....	300,000,000
1881	342,887,000	64,787,000	121,437,000	1,880,000	....	300,000,000
1882	375,000,000	66,000,000	150,000,000	2,200,000	....	350,000,000
1883	269,094,203	82,643,500	129,754,000	1,497,948	....	450,000,000
1884	298,344,591	88,905,520	160,133,000	1,840.278	....	534,674,176
1885	374,138,443	95,992,900	195,880,220	75,000,000	....	600,000,000
1886	207,205,672	77,729,630	158,465,750	1,934,340	....	465,000,000
1887	186,826,521	64,725,580	130,516,200	3,023,235	....	404,302,650
1888	161,309,512	50,544,370	86,348,900	1,500,320	325,971	542,437,000
1889	158,938,294	50,487,355	112,053,075	2,244,786	329,156	400,518,720
1890	166,477,966	46,234,673	78,499,500	1,222,989	342,350	606,992,790
1891	152,040,386	107,841,850	48,700,210	1,258,850	314,085	284,113,430
1892	144,651,150	46,451,170	109,356,000	1,507,050	410,960	632,350,670
1893	159,180,534	43,938,210	108,774,500	1,940,525	459,505	488,926,000
1894	128,703,908	33,550,370	74,183,250	1,420,618	333,157	250,045,730
1895	130,117,213	29,928,099	69,718,000	581,705	327,550	292,640,000
1896	104,715,810	28,952,430	50,814,000	340,184	258,776	297,391,000

Comparative statement of freight and passengers.

Year.	Steamboats.	Freight carried.	Passengers.	Year.	Steamboats.	Freight carried.	Passengers.
		Pounds.				*Pounds.*	
1878	4	Unknown.	Unknown.	1882	3	2,640,000	10,490
1879	4	6,840,000	8,730	1883	3	3,184,000	4,000
1880	4	3,440,000	11,240	1884	2	1,500,000	5,500
1881	3	3,932,000	16,989	1885 to 1896	*a* 1	....	....

a One hundred and eight tons burden and 2 feet draft.

But one steamboat plied regularly on the river since 1885. This boat, the *Phil Sheckel* (108 tons burden and 2 feet draft), ran from the mouth to Dunnville, about halfway between the mouth and Eau Claire, to assist The Knapp, Stout & Co. Company's rafts in floating down the river. Her passengers and freight were confined entirely to the company's rafting business.

Y 4.

IMPROVEMENT OF ST. CROIX RIVER, WISCONSIN AND MINNESOTA.

The project for improvement is to provide a 3-foot channel from Taylors Falls to the Mississippi River, 52.3 miles, by the removal of snags, bowlders, bar, etc., and the contraction of the low-water channel from Taylors Falls to head of Lake St. Croix, a distance of 28.5 miles; by widening and straightening the channel in Lake St. Croix over Hudson and Catfish bars, 6.3 and 15.1 miles, respectively, below head of lake; also the improvement of the harbor and water front of Stillwater, Minn. The latter was added by the river and harbor act passed June 3, 1896, and increased the estimate of cost from $126,000 to $136,700. The original estimate of cost was $21,758. It was revised in 1882 and 1889 (see pages 1798 and 1801, Annual Report, 1889).

At the time of the adoption of the project the depth on many of the bars above Stillwater was but 2 feet. The channel was further obstructed by sunken cribs, wrecks, snags, and old boom piers, and the bends by leaning trees. The channel over Hudson bar, St. Croix Lake, was quite tortuous and shallow, having but 2.5 feet depth at low water. At Catfish the channel had sufficient depth, but made a sharp bend around a long narrow sandy spit that jutted out for a distance of 1,450 feet from the left bank and at right angles to the shore line. When a strong wind blew up or down the lake, the steamboats with heavy rafts encountered considerable difficulty in keeping the channel.

Since 1886, the railroads penetrating the river section have reduced navigation over that reach to almost nothing, except the running of loose logs; as a consequence, little attention has been given to its improvement since 1890.

On the lake section (Stillwater to the mouth) the commerce, consisting of rafted lumber and logs towed by steamboats, is of large proportions and its needs are being met by expending the largest part of appropriations on this reach. By June 30, 1896, channels had been dredged through the Catfish and Hudson bars to a depth of 4 feet at low water and the water directed into new channels by training dams. Many of the partly submerged logs were also removed, but new ones are continually coming into the channel. The work has resulted in creating a fair steamboat channel, 4 feet deep at low water, from Stillwater to the mouth. Boats and rafts can now pass over that distance at the lowest stage, but some work remains to be done in widening the dredged channels and straightening other portions, particularly on the Hudson bar above and below the bridge, and in the construction of additional training dams to maintain the dredged channel. The improvement of the harbor at Stillwater had not been commenced.

Amount expended to June 30, 1896, including outstanding liabilities, $112,471.77.

On account of the excellent condition of the channels that prevailed last fall and the high stage of water during the spring of 1897, no field operations were undertaken except the assembling of part of the material for repairs to training dams, Hudson bar, Lake St. Croix, and examinations, surveys, etc., in preparation for season of 1897.

Amount expended during fiscal year ending June 30, 1897, including outstanding liabilities, $2,215.42, divided as follows:

Material for repairs to training dams, Hudson bar	$447.06
Surveys, examinations, St. Paul office expense, and contingencies	1,768.36
Total	2,215.42

This work is in the collection district of Minnesota, of which St. Paul is the port of entry and St. Vincent a subport. Collections for the year ending December 31, 1896, $244,203.22; value of domestic exports for same period, $116,166.

Abstract of appropriations.

By act—		By act—	
Approved June 18, 1878	$10,000	Of August 11, 1888	$10,000
Approved March 3, 1879	8,000	Approved September 19, 1890	8,000
Approved June 14, 1880	10,000	Approved July 13, 1892	8,000
Approved March 3, 1881	8,000	Of August 17, 1894	4,000
Passed August 2, 1882	30,000	Passed June 3, 1896	15,000
Approved July 5, 1894	9,000		
Approved August 5, 1886	7,500	Total	127,500

Money statement.

July 1, 1896, balance unexpended	$15,036.63
June 30, 1897, amount expended during fiscal year	2,223.82
July 1, 1897, balance unexpended	12,812.81
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	9,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

COMMERCIAL STATISTICS.

Comparative statement of steamboats and barges, freight and passengers carried, and lumber and logs towed and rafted on the St. Croix River, Wisconsin and Minnesota.

STEAMBOATS AND BARGES.

Year.	Freight and passenger business.		Steamboats in towing and rafting business.	Year.	Freight and passenger business.		Steamboats in towing and rafting business.
	Steamboats.	Barges.			Steamboats.	Barges.	
1878	3	....	8	1888	1	3	58
1879	3	....	12	1889	1	1	52
1880	3	....	29	1890	a 2	3	126
1881	2	....	40	1891	1	....	b 130
1882	3	24	77	1892	....	....	b 122
1883	3	25	51	1893	....	....	b 127
1884	3	25	30	1894	a 1	2	b 69
1885	4	33	50	1895	....	....	(c)
1886	6	38	49	1896	....	....	b 60
1887	3	40	58				

a One hundred and seventeen tons burden and 18 inches draft.
b From 35 to 240 tons burden and 2½ to 3½ feet draft.
c Unknown.

FREIGHT AND PASSENGERS.

Year.	Freight carried.			Passengers carried.	Year.	Freight carried.			Passengers carried.
	Lumber.	Wood.	Total.			Lumber.	Wood.	Total.	
	Tons.	*Tons.*	*Tons.*			*Tons.*	*Tons.*	*Tons.*	
1878	(a)	(a)	16,000	15,000	1887	(a)	(a)	28,500	9,872
1879	(a)	(a)	23,893	9,244	1888	5,200	4,354	90,554	(a)
1880	(a)	(a)	(a)	(a)	1889	5,900	4,100	10,000	(a)
1881	(a)	(a)	17,500	11,015	1890	7,139	5,796	b13,144	921
1882	(a)	(a)	30,000	10,300	1891	100	200	300	551
1883	(a)	(a)	31,500	12,800	1894	3,205	(c)	3,205	(c)
1884	(a)	(a)	40,000	4,000	1895	(c)	(c)	(c)	(c)
1885	(a)	(a)	42,500	10,647	1896	(c)	(c)	(c)	(c)
1886	(a)	(a)	90,450	12,756					

a Unknown. b Including 209 tons of general merchandise. c None.

Comparative statement of steamboats and barges, etc.—Continued.

RAFTED LOGS AND LUMBER.

Year.	Rafted logs towed out of St. Croix River (estimated).	Rafted lumber towed out of St. Croix River.				Total tonnage, exclusive of loose logs.	Loose logs run on river above Stillwater.	
		Lumber.	Shingles.	Laths.	Pickets.		Feet B. M.	Tons.
	Feet B. M.	*Feet B. M.*	*Number.*	*Number.*	*Number.*	*Tons.*		
1878..	70,000,000	....	....	....	....	....	....	....
1879..	117,000,000	....	....	....	....	....	....	....
1880..	200,000,000	....	....	....	....	....	....	....
1881..	185,000,000	....	....	....	....	....	....	....
1882..	130,000,000	....	....	....	....	....	....	....
1883..	108,000,000	....	....	....	....	....	....	....
1884..	175,000,000	....	....	....	....	....	....	....
1885..	150,000,000	....	....	....	....	....	....	....
1886..	115,000,000	....	....	....	....	....	....	....
1887..	175,000,000	*a*100,000,000	....	....	....	....	....	....
1888..	136,000,000	114,610,966	*a*40,079,500	*a*23,651,800	*a*570,820	*a*706,367	....	....
1889..	150,000,000	81,817,070	38,633,000	23,226,575	90,800	697,244	....	....
1890..	250,000,000	116,403,000	46,007,000	33,861,900	278,580	1,104,100	*a*460,000,000	*a*1,610,000
1891..	209,233,490	110,934,084	32,016,750	31,132,350	678,240	948,757	315,231,300	1,103,310
1892..	250,000,000	126,503,520	51,959,000	37,387,200	261,040	1,179,549	436,899,770	1,529,149
1893..	160,000,000	63,564,209	23,196,500	18,413,720	118,580	707,745	359,468,740	1,358,141
1894..	150,000,000	105,912,803	38,861,250	28,385,600	1,059,420	805,838	281,470,400	985,146
1895..	213,000,000	133,893,315	22,521,250	33,733,935	840,095	1,021,884	373,062,850	1,305,720
1896..	168,300,000	67,689,498	7,893,750	16,951,700	40,000	724,204	321,764,530	1,126,176

a Unknown previous years.

Y 5.

IMPROVEMENT OF MINNESOTA RIVER, MINNESOTA.

Four examinations, surveys, and projects have been made of this stream since 1866. Reference is made to the Annual Reports for 1894 and 1895 for a résumé of the various estimates and history of the improvement of the river.

The present approved project, adopted in 1875, for improving the river from South Bend to the mouth, 116.4 miles, consists in the construction of locks and dams at an estimated cost of $821,368.63.

The appropriations to 1878, inclusive, aggregate $117,500, and were expended between 1867 and 1879 in surveys and the removal of snags, overhanging trees, and bowlders. The reach worked over extended from Minnesota Falls to a point 9.9 miles above Carver. The work was done to temporarily facilitate high-water navigation, of which in an early day and before the advent of railroads there was a considerable volume. Since 1879 new snags have appeared in such numbers that there are now as many as at any previous time; therefore it can not be said that any permanent improvement was effected.

No work was done on the river between 1879 and 1893, and at no time has Congress authorized the improvement of the river upon the basis of the present approved project—a canalization of the river. After railroads penetrated the Minnesota Valley the navigation of the river practically ceased.

Below Shakopee the river is, in the main, very deep, almost free from snags and caving banks, and would offer exceptional advantages to the navigation thereof were communication between it and the Mississippi River rendered permanent by the improvement at the mouth of the river.

In the fall of 1893 a project was entered into for the improvement of the river below Chaska and Shakopee by building a closing dam at the foot of Pike Island and across the main channel at the mouth of the river and diverting the river during low stages into a channel dredged through the Fort Snelling Chute. For a fuller description of the plan of improvement, see pages 1726 and 1727, Annual Report, 1894.

The closing dam has been built of brush and stone and a temporary channel excavated through the Fort Snelling Chute.

During the past fiscal year additional dredging was done in the chute and the dam was raised 1½ feet in height. As experience has shown that the ice from the spring break-ups would remove the rock from the crest of dam, leaving it uneven, the raising was effected by driving a row of round piles, 8 feet c. to c., along the highest portion of the dam. The piles were capped 2 feet wide and backed with stone. Blue prints of photographs taken of the dam in October, 1893, November, 1896, and May, 1897, are herewith.*

The permanency of the work depends upon a further appropriation for enlarging the channel through Fort Snelling Chute and strengthening the dam.

Amount expended to June 30, 1896, on project at mouth of river, $10,000.

Total amount expended to June 10, 1896, on all parts of the river, $127,500.

Amount expended during fiscal year ending June 30, 1897, $3,943.15.

Abstract of appropriations.

By act—	
Approved March 3, 1867	$37,500
Approved July 11, 1870	10,000
Approved March 3, 1871	10,000
Approved June 10, 1872	10,000
Passed March 3, 1873	10,000
Approved June 23, 1874	10,000
Approved March 3, 1875	10,000

By act—	
Approved August 14, 1876	$10,000
Approved June 18, 1878	10,000
Of August 11, 1888	10,000
Passed June 3, 1896	4,000
Total	131,500

Money statement.

July 1, 1896, balance unexpended	$4,000.00
June 30, 1897, amount expended during fiscal year	3,870.45
July 1, 1897, balance unexpended	129.55
July 1, 1897, outstanding liabilities	72.70
July 1, 1897, balance available	56.85
Amount (estimated) required for completion of existing project	689,868.63
Amount that can be profitably expended in fiscal year ending June 30, 1899	11,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

COMMERCIAL STATISTICS.

Year.	Steamboats plying on lower part of river.			Freight carried.					
	No.	Tonnage.	Draft.	Wheat.	Hay.	Wood.	Brick.	Miscellaneous.	Total.
		Tons.	*Inches.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1888	1								3,850
1889	2	153 180	18 20						4,900
1890	3	117 153 180	18 30 20	62	809	840	1,080	842¼	3,633¼
1896	3	150	30						(†)

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* Not printed.

† Unknown.

There was no traffic on the river during the seasons of 1891, 1892, 1893, 1894, and 1895, as steamboats could not at all times pass the bar at the mouth of the river. The traffic in 1896 was slight, but the opening of the river has induced several boats to prepare for the year 1897.

Y 6.

IMPROVEMENT OF THE RED RIVER OF THE NORTH, MINNESOTA AND DAKOTA.

The history of the project for improvement of the Red River of the North and Red Lake River is fully stated on pages 1856 and 1857, Annual Report for year 1896.

The present approved project, at an estimated cost of $315,320, provides for—

Improving Red River of the North: (1) Breckenridge to Moorhead, 97 miles. A channel capable of being navigated during high and medium stages of water. (2) Moorhead to Grand Forks, 155 miles. A channel 60 feet wide and 3 feet deep at low water. (3) Grand Forks to the northern boundary line, 143.5 miles. A channel 60 feet wide and 4 feet deep at low water.

Improving Red Lake and Red Lake River: (1) Red Lake, 50 miles. A channel 3 feet deep at low water. (2) Red Lake River from Red Lake to High Landing, 50 miles. A channel 3 feet deep at low water. (3) Red Lake River from High Landing to Thief River Falls, 35 miles. A channel 3 feet deep at low water.

RED RIVER OF THE NORTH.

In 1879, when the first bar was dredged through, the ruling depth at ordinary low water between Moorhead and Goose Rapids has been stated to have been but 1.5 feet, and below Grand Forks but 2 feet.

The dredging work to June 30, 1896, resulted in the attainment of the object on the third division, and on the second division except for 13 miles at Goose Rapids. The removal of snags and trees on the first division has bettered the condition of that section during high and medium stages of water.

Expended upon the improvement from the commencement of the work in 1877 to June 30, 1896, $257,462.03.

Operations during the fiscal year ending June 30, 1897.—The dredging fleet was placed in commission August 4, 1896, laid up November 4, 1896, and again placed in commission June 23, 1897. The locality of the work was between Grand Forks and Goose Rapids, and on Goose Rapids. The dredging was confined to previously excavated channels that had subsequently been partly closed by landslides.

The frequency of these landslides has been mentioned in former annual reports. During the past four years the work on the river has been, almost wholly, removing landslides, only 2 miles of new work having been done in that time. The necessity of repair work during the past year has been so urgent that the completion of the project was not advanced.

From examinations made in June, 1897, it is probable that one half of the present working season will be applied to repair work, and the other half to new work on Goose Rapids.

The quantities of work during the past year have been—

Excavation	cubic yards..	26,204
Wing dams	linear feet..	227
Training dams	do....	8,215
Channels cut	do....	8,215
Bowlders removed	cubic yards..	78
Snags removed		2
Overhanging trees removed		11

The steamboat made one trip in April for the relief of flood sufferers. On this trip the boat was sunk by running ice. No serious injury resulted from the sinking of the steamer, as she was readily raised and repaired.

After the close of the season of 1897 the dredging fleet will require extensive repairs before work can be again resumed. The estimated cost of the repairs is $8,100.

For a detailed description of the condition of the plant, as well as an account of the year's work, reference is made to the report of Assistant Engineer R. Davenport.

All the work for the improvement of this stream has been performed by hired labor.

Expended upon this improvement during the fiscal year ending June 30, 1897, including outstanding liabilities, $8,729.31, divided as follows:

Superintendence and St. Paul office expense	$496.31
Care of property	502.67
Relief of flood sufferers	493.25
Operating steamboat and field supervision	3,491.43
Operating dredge and field supervision	3,745.65
Total	8,729.31

RED LAKE RIVER.

The improvement of this river from Thief River Falls to and including Red Lake, a distance of 135 miles, was made a part of the project for the improvement of the Red River of the North by the terms of the river and harbor act passed June 3, 1896. Navigation, at low water, of the river is obstructed by a bar at outlet of Red Lake and by bowlders in the river between Thief River Falls and High Landing. This project will require a reservoir created by a small, low dam at the outlet of Red Lake. It was considered advisable to expend the whole $5,000 appropriated in affording immediate relief in the river channel. A precise estimate of cost of dam should be based upon a survey. It should not exceed, however, the sum of $100,000. It is recommended that the sum of $50,000 be appropriated for continuing the improvement.

Operations during the fiscal year ending June 30, 1897.—A small derrick fleet was constructed by October 28, 1896. Between the latter date and November 8, 1896, when the river was closed by ice, 104 cubic yards of bowlders was removed from the channel, 8 to 13 miles above Thief River Falls. Work will be resumed July 1, 1897.

Amount expended during the past fiscal year, $2,647.10, divided as follows:

Superintendence and St. Paul office expense	$75.22
Care of property	385.00
Construction derrick fleet and field superintendence	2,051.58
Removing bowlders and field superintendence	135.30
Total	2,647.10

Abstract of appropriations.

By act—		By act—	
Approved August 14, 1876	$10,000	Of August 11, 1888	$20,000
Approved June 18, 1878	30,000	Approved September 19, 1890	25,000
Approved March 3, 1879	25,000	Approved July 13, 1892	25,000
Approved June 14, 1880	20,000	Of August 17, 1894	15,000
Approved March 3, 1881	18,000	Passed June 3, 1896	20,000
Passed August 2, 1882	10,000		
Approved July 5, 1884	10,000	Total	278,000
Approved August 5, 1886	50,000		

Money statement.

July 1, 1896, balance unexpended	$20,537.97
June 30, 1897, amount expended during fiscal year	10,189.19
July 1, 1897, balance unexpended	10,348.78
July 1, 1897, outstanding liabilities	1,187.22
July 1, 1897, balance available	9,161.56
Amount (estimated) required for completion of existing project for Red River only	37,320.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	37,320.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

COMMERCIAL STATISTICS.

RED RIVER OF THE NORTH.

The stage of water during the season of 1896 was generally quite favorable for steamboat operations, the range at Grand Forks gauge being from +27 feet in May to +0.6 foot in October, with a rise to +1.4 feet in November before the river was closed by ice.

Steamboat navigation commenced April 22 and closed November 7. The river was clear from ice from April 18 to November 8. The boats operated on the river were the Red River Transportation Company's steamer *Grand Forks*, 100 tons, with 3 barges of 127 tons each, and the gasoline boat *City of Grand Forks*, 12 tons, with 2 barges of 40 tons each.

The following is a statement of the freight moved by the boats during the season of 1896:

Red River Transportation Company's steamer *Grand Forks* and three barges:		
To Grand Forks from points north: Wheat	tons	6,824
To Grand Forks from points south: Wheat	do	6,551
To Grand Forks from points north and south: Wood	do	1,800
From Grand Forks to points north and south:		
Merchandise	do	59½
Lumber	do	67½
Gasoline boat *City of Grand Forks* and 2 barges:		
To Grand Forks from points north and south:		
Wheat	do	2,009
Flax	do	30
Wood	do	112
From Grand Forks to points north and south: Merchandise	do	5
Total		17,786

Comparative statemen of freight moved by steamboats and barges during the past eighteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1896	17,786	1890	1,710	1884	29,046
1895	9,413	1889	3,866	1883	25,314
1894	7,684	1888	12,140	1882	31,652
1893	5,723	1887	10,405	1881	26,557
1892	14,256	1886	10,507	1880	21,651
1891	12,137	1885	23,045	1879	17,829

RED LAKE RIVER.

The stage of water in Red Lake River was favorable for steamboat operations during the entire season of 1896, no difficulty whatever being experienced, except during the fall months, from obstructions in the channel on the rapids.

The boats operated on the river were the *Alice Meehan*, owned by Meehan Bros., and *Viking No. 1* and *Viking No. 2*, owned by Hanson Bros., all of Thief River Falls.

On Red Lake two large steamboats, owned by Meehan Bros. and T. B. Walker, were engaged in moving logs on the lake, but no detail of that work was obtainable.

Such statistics as could be obtained for the year 1895 are also presented herewith. The water in 1895 was low the entire season.

Season of 1895.

Steamer *Alice Meehan*, 50 tons:		
Freight (Thief River Falls to Red Lake)	tons	145½
Passengers (Thief River Falls to Red Lake and return)		281
Trips made		35
Run of logs from Red Lake in 1895	million feet B. M.	15

Season of 1896.

Steamer *Alice Meehan:*		
Freight (Thief River Falls to Red Lake)	tons	112
Passengers (Thief River Falls to Red Lake and return)		639
Trips made		41
Steamer *Viking No. 1:*		
Freight (Thief River Falls to Red Lake)	tons	21
Passengers (Thief River Falls to Red Lake and return)		51
Trips made		7
Steamer *Viking No. 2:*		
Freight (Thief River Falls to Red Lake)	tons	65
Passengers (Thief River Falls to Red Lake and return)		24
Trips made		4
Run of logs from Red Lake in 1896	million feet B. M.	20

Summary for 1896.

Freight	tons	198
Passengers		714
Trips		52
Run of logs	million feet B. M.	20

REPORT OF ASSISTANT ENGINEER R. DAVENPORT.

GRAND FORKS, N. DAK., *June 30, 1897.*

COLONEL: The following report of operations in the improvement of the Red River of the North during the fiscal year ending June 30, 1897, is respectfully submitted:

GENERAL IMPROVEMENT.

Season of 1896.—The work done during the last half of the season of 1896 was on the second, or Goose Rapids, section of the river, south of Grand Forks, N. Dak., and consisted of channel dredging and the removal of bowlders, snags, etc.

The preparation of the fleet for active operations was commenced August 4; the work was closed and the fleet laid up November 4. During this period of three months, 18 channel excavations were made, extending over some 23 miles of river; 11 of these channel cuttings were on Goose Rapids, between Bellmont and Sand Hill River, a section of river previously worked over by the dredge, but where it was again necessary to excavate several new bars, and to extend and widen some of the old cuttings, to permit the passage of boats at low water. The remainder of the channel cuttings were north of Bellmont, on a section of river where little or no dredge work had previously been required. All of this season's work was rendered necessary by land slides or the settling of the adjacent high banks of the river.

Total excavation, 24,704 cubic yards. Length of channel cut, 7,765 linear feet. Training dams formed with the excavated material, 7,765 linear feet; wing dams, 227 linear feet. Cost of dredge excavation, 17.6 cents per cubic yard. Cost of subsistence, per ration, 34 cents.

The steamer *Ogama* operated in connection with the dredge, towing the fleet, keeping up the supply of fuel, etc., and also occupied with the removal of obstructions from the channel, made 29 trips. Total miles run, 988. Wood loaded, 152 cords. Bowlders removed from channel, 139, equal to 78 cubic yards of stone. Overhanging trees removed, 11; snags, 2.

The cost of operating the steamboat is included in the cost of general work.

Season of 1897.—Owing to the extreme high water in the Red River this spring—45.2 feet on the Grand Forks gauge at the height of the flood in April—and in part to the sinking by ice of the steamer *Ogama* while on an expedition for the relief of the flood sufferers in the Red River Valley, the work of improvement on the river was delayed until June 14.

The steamboat, by the way, was raised April 26, uninjured in any way excepting the hole in the side of the hull that caused the sinking, which was readily repaired without removing the boat from the water.

The work so far accomplished this season consists only of the outfitting and towing of the dredging fleet to Goose Rapids and the beginning of the channel cutting in that locality.

Total excavation, 1,500 cubic yards; channel cut, 450 linear feet; training dams formed with excavated material, 450 linear feet; trips made by steamboat, 3; total miles run, 126; wood loaded, 36½ cords.

Dredge work in detail.

Location.	Number of cut.	Excavation.	Training dams.	Wing dams.	Channel cut.	Miles of river worked over.
Season of 1896.		*Cub. yds.*	*Lin. ft.*	*Lin. ft.*	*Lin. ft.*	
Sec. 26, T. 148, R. 49	1	3,511	1,000	....	1,000	....
Sec. 26, T. 148, R. 49	2	1,934	500	....	500	¼
Sec. 23, T. 148, R. 49	3	2,003	600	30	600	⅛
Sec. 23, T. 148, R. 49	4	3,092	1,225	50	1,225	¼
Sec. 26, T. 148, R. 49	5	2,750	675	....	675	¼
Sec. 25, T. 148, R. 49	6	2,105	550	35	550	¼
Sec. 26, T. 148, R. 49	7	1,524	740	40	740	⅛
Sec. 36, T. 148, R. 49	8	2,587	575	12	575	¼
Sec. 26, T. 148, R. 49	9	785	150	60	150	⅜
Sec. 23, T. 148, R. 49	10	333	100	....	100	⅛
Sec. 23, T. 148, R. 49	11	263	100	....	100	1
Sec. 23, T. 148, R. 49	12	477	150	....	150	⅛
Sec. 23, T. 148, R. 49	13	755	150	....	150	⅛
Sec. 3, T. 148, R. 49	14	903	400	....	400	4
Sec. 33, T. 150, R. 49	15	363	200	....	200	11
Sec. 20, T. 150, R. 49	16	144	100	....	100	4
Sec. 20, T. 150, R. 49	17	222	100	....	100	⅛
Sec. 20, T. 150, R. 49	18	953	450	....	450	⅛
Total	......	24,704	7,765	227	7,765	23
Season of 1897.						
Sec. 13, T. 147, R. 49	1	1,500	450	....	450	....

In connection with the dredging operations on the Red River of the North attention is respectfully called to the necessity of repairing the dredging fleet before another season's work can be carried on with the present outfit.

As mentioned in the report of June 30, 1895, dredge *Otter Tail*, the only dredge on the river, was estimated at that time to be sufficiently stable for two seasons' work, and it is now found that the serviceable limit has been reached, as was then estimated.

The machinery on the boat is in good and serviceable condition, and the cabin is in good repair, but the hull and "A braces" are so far decayed as to render further use unsafe. Dredge *Otter Tail* was built during the winter of 1881–82, and has been in almost constant service since that time. It is estimated that $3,750 will be required to put the dredge in thorough repair.

In addition to the dredge, the following boats of the fleet will also require more or less extensive repairs before work can be resumed after this season:

The steamer *Ogama*, as previously mentioned, sunk by ice this spring, is in absolute need of a new hull. This boat was built in the spring of 1887, and has been in almost constant service since that time, with but little repair. When raised from the water this spring and temporarily repaired, it was found that the cause of the sinking had been the badly decayed condition of the timbers and outside planking of the hull.

The machinery and superstructure of the boat are in very good condition and will readily outlast another hull. Estimated cost of a new hull for the steamer *Ogama*, $2,500.

Barges Nos. 3 and 4, recalking and painting; estimated cost, $200. Barge No. 2, complete repair; estimated cost, $750. Slide scow No. 1, complete repair, $800.

Slide scow No. 1 and barge No. 2 were built in 1882, and have been from time to time repaired; they are, in their present condition, past being in any way serviceable.

Quarter boat No. 2, recalking and painting, $100. Barge No. 5, recalking and painting, $50.

The above-mentioned boats, with the exception of quarter boat No. 1 and barge No. 1, which are now past service and are recommended for condemnation, constitute the entire Red River dredging fleet.

Quarter boat No. 1 and barge No. 1, recommended to be condemned, were built in 1879, and were used with the dredge *Unser Fritz*. Since the demolition of that dredge they have not been required for the work, and as they are both now unserviceable and unseaworthy, can readily be dispensed with. All of the remaining boats are, however, necessary for the proper conduct of the work.

Summary of estimated cost of repairs.

Dredge *Otter Tail*, new hull and "A braces"	$3,750
Steamer *Ogama*, new hull	2,500
Barges Nos. 3 and 4, recalking and painting	200
Barge No. 1, complete repair	750
Slide scow No. 1, complete repair	800
Quarter boat No. 2, recalking and painting	100
Barge No. 5, recalking and painting	50
Total	8,100

The total work done on this stream since the first appropriation for its improvement was made in 1876, extending from Fort Abercrombie north to the boundary line, a total river distance of 395.5 miles, is as follows:

Material dredged	cubic yards	813,689
Snags removed		667
Bowlders removed	cubic yards	509
Overhanging trees removed		8,763
Stumps removed		198
Piles removed		23
Drift piles (collection of driftwood, snags, etc.)		8
Barge removed		1
Channel excavated	linear feet	168,424
Wing and training dams constructed	do	213,847

On the portion of the river worked over and maintained by the dredge the average depth of channel has been increased from 1½ to 2 feet.

Red Lake River (season of 1896).—The work of improvement of Red Lake River by the removal of obstructions from the channel between Thief River Falls and High Landing, a distance of about 50 miles by water, was commenced September 28 by beginning the construction of a small derrick fleet at Thief River Falls, Minn. The boats were of construction and capacity as follows:

No. 1 derrick boat: 42 feet long, 18 feet wide, depth 2 feet 5 inches, fitted with hand derrick and capstan. With the derrick crab and blocks sufficient power can be developed to lift 12 tons.

No. 2 quarter boat: 52 feet long, 12 feet wide, depth of hull 2 feet; with 40 feet cabin, 11 feet 6 inches wide, and 7 feet 2 inches high. The cabin is divided into cook and dining room, bunk room, and cabin and office. The boat has capacity for crew of 16 men.

No. 3 flatboat or lighter: 24 feet long, 14 feet wide, depth 2 feet 5 inches.

The cost of derrick fleet, including tools and complete outfit, was $2,366.81.

The construction of the boats was completed and the fleet towed up river to the rapids, about 8 miles above Thief River Falls, October 28, when the removal of obstructions from the channel was at once commenced.

During the nine following days that the river remained free from ice 381 bowlders, about 104 cubic yards of stone, ranging in size from a small "nigger head" to an 80 cubic foot bowlder, were removed from the channel.

Length of river worked over, 5 miles. The river was blocked by ice and the work closed November 8.

Cost of removal of obstructions from the channel, $2.41 per cubic yard. Cost of subsistence per ration, 40 cents.

Season of 1897.—Owing to high water in Red Lake River there has as yet been no work done this season. The water is, however, expected to reach a favorable stage about the 1st of July, and preparations have been made to resume operations on or about that date.

Very respectfully, your obedient servant,

R. Davenport,
Assistant Engineer.

Lieut. Col. W. A. Jones,
Corps of Engineers, U. S. A.

Y 7.

GAUGING MISSISSIPPI RIVER AT OR NEAR ST. PAUL, MINNESOTA.

The Board of Engineers, to whom was referred the project for the application of $37,500 appropriated by the river and harbor act of August 5, 1886, for reservoirs at the head waters of the Mississippi River, recommended in their report dated May 24, 1887, "that such gaugings be made at or near St. Paul during the annual operation of the reservoirs as shall determine accurately the discharge at that point at critical periods." (Annual Report Chief of Engineers, 1887, p. 1692.)

The river and harbor act of August 11, 1888, authorized the gaugings, but none were made until the fall of 1889, although an allotment of $900 for the fiscal year ending June 30, 1889, had been made. The sum was not expended on account of the lateness of the season and the condition of the river.

For the purpose of preserving a concise record of the volume of the Mississippi River at St. Paul, all gaugings made at that point by this office during the past year are included in the list below.

Table of gaugings made at St. Paul, Minn., during the fiscal year ending June 30, 1897.

[Location: Above Robert Street Bridge. Observer: Kent Nelson. Method: Ellis current meter No. 18.]

No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1896.		*Cub. feet.*	
1	July 1	5.65	11,821	Wind downstream.
2	July 2	5.39	11,090	
3	July 10	4.27	9,022	Do.
4	July 11	4.13	8,484	River falling.
5	July 14	4.02	8,697	River rising.
6	July 15	3.73	7,602	
7	July 16	3.40	7,154	
8	July 17	3.20	6,490	Wind downstream.
9	July 18	3.00	6,369	
10	July 20	2.85	6,362	Do.
11	July 21	2.89	6,276	
12	July 22	2.72	6,141	Side wind.
13	July 24	2.60	5,775	Wind downstream.
14	July 25	2.60	5,882	Do.
15	July 27	2.30	5,339	Wind upstream.
16	July 28	2.13	5,079	Wind downstream.
17	July 29	1.98	4,748	Do.
18	July 30	1.80	4,541	Wind upstream.
19	July 31	1.80	4,451	
20	Aug. 1	1.80	4,770	Do.
21	Aug. 5	1.92	4,785	Wind downstream.
22	....do...	1.70	4,406	
	1896.		*Cub. feet.*	
23	Aug. 6	1.70	4,409	Wind upstream.
24	Aug. 7	1.82	4,708	Do.
25	Aug. 8	2.17	5,400	Wind downstream.
26	Aug. 10	2.02	4,776	Do.
27	Aug. 11	2.22	5,268	
28	Aug. 12	2.40	5,815	Wind upstream.
29	Aug. 13	2.52	5,762	
30	Aug. 14	2.55	5,950	Wind downstream.
31	Aug. 15	2.60	6,055	Wind upstream.
32	Aug. 17	2.39	5,707	Wind downstream.
33	Aug. 18	2.28	5,273	Wind upstream.
34	Aug. 19	2.21	5,207	Wind downstream.
35	Aug. 20	2.13	5,000	Do.
36	Aug. 21	2.11	5,143	Do.
37	Aug. 22	2.05	5,086	Do.
38	Aug. 24	2.08	5,127	Do.
39	Aug. 25	2.19	5,341	Wind downstream.
40	Aug. 27	1.92	4,761	
41	Aug. 28	2.00	4,762	Do.
42	Aug. 29	1.95	5,021	Do.
43	Sept. 8	1.70	4,574	
44	Sept. 9	1.80	4,341	

Table of gaugings made at St. Paul, Minn., etc.—Continued.

[**Location**: Above Robert Street Bridge. **Observer**: Kent Nelson. **Method**: Ellis current meter No. 7.]

No.	Date.	Reading of Signal Service gauge St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge St. Paul.	Discharge per second.	Remarks.
	1896.		*Cub. feet.*			1896.		*Cub. feet.*	
45	Sept. 30	2.05	5,334		47	Oct. 2	2.00	5,519	
46	Oct. 1	2.1	5,713		48	Oct. 3	2.05	5,418	

[**Location**: Above Robert Street Bridge. **Observer**: W. T. Hutchins. **Method**: Ellis current meter No. 7.]

	1896.		*Cub. feet.*			1896.		*Cub. feet.*	
49	Nov. 3	2.85	6,411		52	Nov. 7	2.80	6,344	
50	Nov. 4	2.80	6,378		53	Nov. 16	1.80	4,586	
51	Nov. 5	2.80	6,445		54	Nov. 18	2.00	4,936	

[**Location**: One-eighth mile above Chestnut street. **Observer**: W. T. Hutchins. **Method**: Ellis current meter No. 7.]

	1896.		*Cub. feet.*			1896.		*Cub. feet.*	
55	Dec. 2	Frozen..	4,997		57	Dec. 4	Frozen..	4,493	
56	Dec. 3	....do ...	4,581						

[**Location**: One-eighth mile above Chestnut street. **Observer**: W. T. Hutchins. **Method**: Ellis current meter No. 7 and Herschel No. 12.]

	1896.		*Cub. feet.*						
58	Dec. 5	Frozen..	4,553	Average of 3 gaugings.	.....	....	....	....	

[**Location**: One-eighth mile above Chestnut street. **Observer**: W. T. Hutchins. **Method**: Ellis current meter No. 7.]

	1896.		*Cub. feet.*			1897.		*Cub. feet.*	
59	Dec. 9	Frozen..	4,386		81	Jan. 29	....do ...	3,052	
60	Dec. 10	....do ...	4,298		82	Jan. 30	....do ...	3,202	
61	Dec. 21	....do ...	4,244		83	Feb. 2	....do ...	3,451	
62	Dec. 22	....do ...	4,530		84	Feb. 3	....do ...	3,323	
63	Dec. 23	....do ...	4,151		85	Feb. 4	....do ...	3,326	
64	Dec. 28	....do ...	4,668		86	Feb. 5	....do ...	3,399	
65	Dec. 30	....do ...	4,430		87	Feb. 12	....do ...	3,551	
66	Dec. 31	....do ...	4,501		88	Feb. 13	....do ...	3,486	
	1897.				89	Feb. 17	....do ...	3,385	
67	Jan. 2	....do ...	5,336		90	Feb. 18	....do ...	3,168	
68	Jan. 6	....do ...	4,812		91	Feb. 19	....do ...	3,129	
69	Jan. 8	....do ...	5,207		92	Feb. 20	....do ...	3,178	
70	Jan. 9	....do ...	5,100		93	Feb. 24	....do ...	3,392	
71	Jan. 11	....do ...	5,241		94	Feb. 25	....do ...	3,273	
72	Jan. 12	....do ...	4,501		95	Feb. 27	....do ...	3,119	
73	Jan. 13	....do ...	4,518		96	Mar. 3	....do ...	3,361	
74	Jan. 15	....do ...	4,596		97	Mar. 5	....do ...	3,318	
75	Jan. 16	....do ...	4,388		98	Mar. 6	....do ...	3,168	
76	Jan. 19	....do ...	4,235		100	Mar. 9	....do ...	3,324	
77	Jan. 20	....do ...	4,076		101	Mar. 10	....do ...	3,152	
78	Jan. 23	....do ...	3,477		102	Mar. 12	....do ...	3,318	
79	Jan. 27	....do ...	3,301		103	Mar. 13	....do ...	2,999	
80	Jan. 28	....do ...	3,340		104	Mar. 16	....do ...	3,175	

[**Location**: One-eighth mile above Chestnut street. **Observer**: W. T. Hutchins. **Method**: Ellis current meter No. 23.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
105	Mar. 17	Frozen..	3,158		107	Mar. 19	Frozen..	4,247	
106	Mar. 18	....do ...	3,321		108	Mar. 20	....do ...	5,441	

Table of gaugings made at St. Paul, Minn., etc.—Continued.

[Location: On Great Western Railroad Bridge. Observer: A. O. Powell. Method: Ellis current meter No. 8.]

No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1897.		*Cub. feet.*						
109	Apr. 5	17.98	85,293		.....	....	....	....	

[Location: On Great Western Railroad Bridge. Observer: W. C. Weeks. Method: Ellis current meter No. 8 and No. 21.]

	1897.		*Cub. feet.*						
110	Apr. 7	17.77	81,450		.....	....	....	....	

[Location: On Great Western Railroad Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 21.]

	1897.		*Cub. feet.*						
111	Apr. 10	17.70	86,653		.....	....	....	....	

[Location: On Great Western Railroad Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
112	Apr. 13	16.55	71,904		114	Apr. 17	14.84	59,592	
113	Apr. 15	15.57	65,217		115	Apr. 20	13.59	49,827	

[Location: Above Robert Street Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
116	Apr. 23	12.55	42,991		120	May 4	9.06	25,698	
117	Apr. 27	11.37	36,506		121	May 6	8.43	22,771	
118	Apr. 29	10.57	32,787		122	May 8	7.81	20,568	Wind across stream.
119	May 1	9.98	29,650	Wind up-stream.					

[Location: Above Robert Street Bridge. Observer: W. C. Smiley. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*						
123	May 10	7.21	18,142	Wind quartering down-stream.	.....	....	....	....	....

[Location: Above Robert Street Bridge. Observer: W. O. Stout. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
124	May 12	6.96	17,184	Wind up-stream.	126	May 19	6.43	15,549	Wind down-stream.
125	May 17	6.47	15,777	Wind down-stream.	127	May 21	6.36	14,380	Wind up-stream.

Table of gaugings made at Fort Snelling, Minn., above the mouth of the Minnesota River, during the fiscal year ending June 30, 1897.

[**Location**: Half mile above Fort Snelling Bridge. Observer: Kent Nelson. Method: Ellis current meter No. 7.]

No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1896.		*Cub. feet.*			1896.		*Cub. feet.*	
1	Oct. 1	2.10	4,757		7	Oct. 10	1.90	4,512	Morning gauging.
2	Oct. 2	2.00	4,673						
3	Oct. 3	2.05	4,473		8	Oct. 12	2.15	5,442	
4	Oct. 5	1.95	4,883		9	Oct. 13	2.10	5,118	
5	Oct. 6	2.20	4,571		10	Oct. 14	2.10	5,088	
6	Oct. 9	1.90	4,489		11	Oct. 15	2.20	4,941	

[**Location**: Half mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 7.]

	1896.		*Cub. feet.*			1896.		*Cub. feet.*	
12	Oct. 16	2.20	4,755		20	Nov. 3	2.85	5,874	
13	Oct. 17	2.20	5,049		21	Nov. 4	2.80	5,835	
14	Oct. 19	2.10	5,139		22	Nov. 5	2.80	6,022	
15	Oct. 24	2.00	4,633		23	Nov. 6	2.80	5,943	
16	Oct. 26	2.00	4,893		24	Nov. 9	....	5,730	
17	Oct. 27	2.00	4,564		25	Nov. 17	....	4,682	
18	Oct. 30	2.27	5,263		26	Nov. 18	....	4,464	
19	Oct. 31	2.30	5,442						

[**Location**: One mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 7.]

	1896.		*Cub. feet.*			1897.		*Cub. feet.*	
27	Nov. 30	Frozen .	4,792		40	Jan. 12	Frozen..	2,983	
28	Dec. 2	....do ...	3,859		41	Jan. 13	....do ...	3,038	
29	Dec. 3	....do ...	4,337		42	Jan. 15	....do ...	3,046	
30	Dec. 4	....do ..	4,738		43	Jan. 16	....do ...	2,917	
31	Dec. 5	....do ...	4,503		44	Jan. 20	....do ...	2,528	
32	Dec. 8	....do ...	4,134		45	Jan. 21	....do ...	2,602	
33	Dec. 9	....do ...	3,971		46	Mar. 29	10.60	11,556	One-eighth mile above Fort Snelling Bridge.
34	Dec. 10	....do ...	3,741						
35	Dec. 11	....do ...	3,662						
36	Dec. 12	....do ...	3,612		47				
37	Dec. 14	....do ...	4,526		48	Mar. 31	13.92	25,387	Do.
	1897.					Apr. 3	17.15	51,496	Do.
38	Jan. 9	....do ...	3,686						
39	Jan. 11	....do ...	4,264						

[**Location**: One-eighth mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 21.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
49	Apr. 8	17.72	50,455		51	Apr. 12	16.90	39,819	
50	Apr. 9	17.79	46,939						

[**Location**: One-eighth mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
52	Apr. 14	16.08	35,892		57	Apr. 28	10.91	21,271	
53	Apr. 16	15.15	32,490		58	Apr. 30	....	19,211	
54	Apr. 19	14.45	30,581		59	May 3	9.41	18,300	
55	Apr. 22	....	25,833		60	May 5	8.75	16,573	
56	Apr. 26	11.69	22,789		61	May 7	8.09	14,983	

Table of gaugings made at Fort Snelling, Minn., etc.—Continued.

[Location: One-eighth mile above Fort Snelling Bridge. Observer: W. O. Stout. Method: Ellis current meter No. 18.]

No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.	No.	Date.	Reading of Signal Service gauge, St. Paul.	Discharge per second.	Remarks.
	1897.		*Cub. feet.*						
62	May 11	7.09	12,632	Quartering downstream.					

[Location: One-eighth mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*						
63	May 14	6.70	12,008	Wind upstream.					

[Location: One-eighth mile above Fort Snelling Bridge. Observer: W. O. Stout. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
64	May 18	6.43	11,863	Wind downstream.	66	May 22	6.10	10,824	Wind upstream.
65	May 20	6.42	12,265	Do.					

[Location: One-eighth mile above Fort Snelling Bridge. Observer: Kent Nelson. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
67	May 25	5.70	10,493		69	May 31	5.36	10,319	
68	May 27	5.50	9,775						

[Location: One-eighth mile above Fort Snelling Bridge. Observer: W. T. Hutchins. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
70	June 2	5.56	9,656	Wind upstream.	71	June 4	5.55	10,166	Wind downstream.

[Location: One-eighth mile above Fort Snelling Bridge. Observer: Kent Nelson. Method: Ellis current meter No. 18.]

	1897.		*Cub. feet.*			1897.		*Cub. feet.*	
72	June 7	6.00	12,090	Wind upstream.	77	June 18	6.16	12,637	
73	June 9	5.87	11,598	Do.	78	June 21	6.69	15,113	
74	June 11	6.00	11,562		79	June 23	6.80	15,027	
75	June 14	5.83	12,284		80	June 25	6.50	14,850	
76	June 16	5.93	12,908		81	June 28	6.26	14,200	

The effect of the reservoir water upon the Mississippi River at St. Paul during low-water periods and the manner of making the gaugings is described on page 1861, Appendix Y, Annual Report for 1896.

The gaugings made during the years 1894, 1895, and 1896, supplemented by the gauge readings, are sufficient for a close determination of the total discharge.

Relation of run-off to rainfall on the watershed of the Mississippi River above St. Paul, Minn., years 1894, 1895, and 1896.

[Area of watershed, 36,081 square miles.]

Year.	Rainfall.					Total rainfall.	
	2.	3.	4.	5.	6.	7.	8.
	Mean at Leech Lake, Lake Winnibigoshish, and Pokegama Falls dams.	At St. Paul, Minn.	At Morris, Minn.	Assumed mean over drainage area.	Total since Jan. 1, 1894.	By calendar years.	Since Jan. 1, 1894.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Cubic feet.*	*Cubic feet.*
1894	26.63	25.80	18.22	23.55	23.55	1,974,040,580,160	1,974,040,580,160
1895	25.11	24.26	16.77	22.05	45.60	1,848,305,511,360	3,822,346,091,520
1896	32.97	31.01	30.96	31.65	77.25	2,653,009,951,680	6,475,356,043,200

Year.	Run-off.		Average volume of river per second.		Proportion of run-off to rainfall.		Average volume of run-off per second per square mile.	
	9.	10.	11.	12.	13.	14.	15.	16.
	By calendar years.	Since Jan. 1, 1894.	By calendar years.	Since Jan. 1, 1894.	By calendar years.	Since Jan. 1, 1894.	By calendar years.	Since Jan. 1, 1894.
	Cubic feet.	*Cubic feet.*	*Cu. ft.*	*Cu. ft.*	*Per ct.*	*Per ct.*	*Cu. ft.*	*Cu. ft.*
1894	227,515,289,600	227,515,289,600	7,215	7,215	11.53	11.53	0.200	0.200
1895	123,358,457,600	350,873,747,200	3,912	5,563	6.67	9.18	0.108	0.154
1896	268,543,392,400	619,417,139,600	8,492	6,529	10.12	9.57	0.235	0.181

The assumed mean rainfall over drainage area may be in error, though it is believed to be as correct an approximation as existing records will furnish. The position of the rainfall-record stations may be seen on the map submitted with the report on reservoirs at head waters of Mississippi River for 1896. The drainage area above St. Paul contains two distinct meteorological basins, drained respectively by the Minnesota River and the Mississippi River above the mouth of the Minnesota. The depth of rainfall on the former is less than on the latter, and the ratio of run-off to rainfall for the two areas is correspondingly different. The ratio for the Minnesota River is undoubtedly considerably less than the figures given in the table for the combined basins, and for the Mississippi River above the Minnesota the ratio is unquestionably greater.

The gaugings and computations pertaining thereto have been made under the supervision of Assistant Engineer Archibald O. Powell.

Amount expended during fiscal year ending June 30, 1897, $500.

Abstract of allotments.

For fiscal year ending June 30—		For fiscal year ending June 30—	
1889	*$900.00	1894	$500.00
1890	600.00	1895	500.00
1891	900.00	1896	500.00
1892	900.00	1897	500.00
1893	500.00	1898	500.00

* Not used.

Money statement.

Amount allotted for fiscal year ending June 30, 1897	$500.00
Amount allotted for fiscal year ending June 30, 1898	500.00
	1,000.00
June 30, 1897, amount expended during fiscal year	500.00
July 1, 1897, balance unexpended	500.00

Itemized statement of expenditures during the fiscal year ending June 30, 1897.

Date.	To whom paid.	For what paid.	Amount.
1896.			
Aug. 14	A. O. Powell	Services	$60.00
Oct. 29	Robinson & Cary Co	Wire rope, etc	42.37
Nov. 30	Goodyear Rubber Co	Rubber gloves	.88
30	F. E. Messing	Stamps, etc	1.70
30	St. Paul Furniture Co	Repair work	2.25
Dec. 29	Ryan Drug Co	Brushes, etc	2.53
1897.			
Jan. 8	W. T. Hutchins	Travel expenses	7.22
14	T. H. Plumleigh	Drayage	2.00
20	Robinson & Cary Co	Ax. etc.	3.10
22	Boeringer & Son	Repair work	1.50
27	Zimmerman Bros	Paste, etc	1.10
Feb. 2	W. T. Hutchins	Travel expenses	7.35
26	Robinson & Cary Co	T rails, etc	21.32
26	Boeringer & Son	Repair work	1.10
26	Henry E. Wedelstaedt	Stationery	9.32
26	Pioneer Press Co	Blanks	2.00
Mar. 9	W. T. Hutchins	Travel expenses	3.25
10	George T. Harris	Hauling	2.00
17	Geo. J. Grant	Lumber, etc	90.36
23	Goodyear Rubber Co	Gloves	.88
Apr. 2	W. T. Hutchins	Travel expenses	6.05
15	Minnesota Engine Works	Sounding leads	3.44
15	St. Croix Lumber Co	Lumber	1.68
15	Robinson & Cary Co	Rope, etc	5.56
15	N. W. Engineering Co	Batteries	3.00
26	St. Paul Hardware Co	Hardware	6.85
26	Robinson & Cary Co	Winch, sheave, etc	7.94
26	Board Water Commissioners	Putting in meter	6.68
26	Kuhle & Ellerbe	Repair work	1.75
26	Minnesota Engine Works	do	4.50
27	Robinson & Cary Co	Wire rope, etc	24.33
May 3	W. T. Hutchins	Travel expenses	9.20
20	Minnesota Engine Works	Job work	2.37
20	N. W. Engineering Co	Tape	.90
20	American Express Co	Express charges	.60
26	Boeringer & Son	Tape, etc	13.15
June 1	W. T. Hutchins	Travel expenses	1.40
3	A. O. Powell	do	5.88
16	Sundry persons	Emergency purchases	7.49
30	do	Pay roll for June	125.00
	Total		500.00

Y 8.

PRELIMINARY EXAMINATION OF MILLE LACS LAKE, MINNESOTA, WITH A VIEW TO THE CONSTRUCTION OF A DAM AT THE OUTLET ON SEC. 33, T. 33 N., IN R. 27 W., IN MILLE LACS COUNTY, FOR THE AID OF NAVIGATION ON THE MISSISSIPPI RIVER, THE SAME TO BE PART OF THE GENERAL UPPER MISSISSIPPI RIVER RESERVOIR SYSTEM.

[Printed in House Doc. No. 305, Fifty-fourth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, D. C., February 18, 1897.

Sir: The river and harbor act of June 3, 1896, directs the Secretary of War to cause a preliminary examination to be made at the following locality, viz:

Mille Lacs Lake, Minnesota, with a view to the construction of a dam at the outlet on section 33, township 33 north, in range 27 west, in Mille Lacs County, for the aid of navigation on the Mississippi River, the same to be part of the general Upper Mississippi River reservoir system.

The duty of making the examination thus provided for was assigned to the charge of Lieut. Col. W. A. Jones, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, dated February 4, 1897, upon the subject.

The report of Colonel Jones indicates the practicability of constructing a reservoir at the head waters of Rum River, but I can not express the opinion at the present time that such a dam is necessary for the aid of navigation on the Mississippi River.

Reservoir dams have already been constructed at Lake Winnibigoshish, Leech Lake, Pokegama Falls, Pine River, and Sandy Lake, and the construction of an additional reservoir at Gull Lake is authorized.

In my opinion it is advisable to defer action in regard to a reservoir at the head of Rum River until the absolute effect of those already authorized is fully determined and the necessity for additional reservoirs made more evident.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 4, 1897.

GENERAL: I have the honor to make the following report of preliminary examination of—

Mille Lacs Lake, Minnesota, with a view to the construction of a dam at the outlet on section 33, township 33 north, in range 27 west, in Mille Lacs County, for the aid of navigation on the Mississippi River, the same to be part of the general Upper Mississippi River reservoir system,

made by me in accordance with the provision of section 8 of the river and harbor act of June 3, 1896.

This lake is at the head waters of Rum River, a tributary of the Mississippi in Minnesota. There is a lake area of 199 square miles. The area of its watershed is 406.2 square miles. The average rainfall in that locality is about 26 inches per year. It is estimated that the evaporation from the lake area is about 85 per cent of the rainfall, leaving 15 per cent of 26 inches over the same as available for storage purposes. It is estimated that 20 per cent of the rainfall on the dry area can be collected—that is to say, about 4,462,000,000 cubic feet may be collected in Mille Lacs in an average year. There is a good dam site a short distance below the lake, and the cost of a dam would be quite small. For these reasons I consider the locality worthy of improvement.

Very respectfully, your obedient servant,

W. A. JONES,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Y 9.

PRELIMINARY EXAMINATION OF OTTER TAIL LAKE AND OTTER TAIL RIVER, MINNESOTA, WITH A VIEW TO THE CONSTRUCTION OF A DAM AT THE OUTLET OF SAID LAKE, FOR THE PURPOSE OF IMPROVING THE NAVIGATION ON THE RED RIVER OF THE NORTH.

[Printed in House Doc. No. 325, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 26, 1897.

SIR: The river and harbor act of June 3, 1896, directs the Secretary of War to cause a preliminary examination to be made at the following locality, viz:

> Otter Tail Lake and Otter Tail River, Minnesota, with a view to the construction of a dam at the outlet of said lake for the purpose of improving the navigation on the Red River of the North.

The duty of making the examination thus provided for was assigned to the charge of Lieut. Col. W. A. Jones, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, dated February 6, 1897, upon the subject.

The report of Colonel Jones indicates the practicability of constructing a reservoir at this locality; but I am unable with the data now available to express an opinion as to the amount of improvement to navigation which would result from the construction of the proposed dam or the relation of cost to the interests of commerce involved.

I consider the project worthy to the extent of making a survey, which will furnish the information necessary for forming an opinion as to the merits of the improvement proposed. It is estimated that such a survey would cost $3,000.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 6, 1897.

GENERAL: I have the honor to make report of the preliminary examination of—

> Otter Tail Lake and Otter Tail River, Minnesota, with a view to the construction of a dam at the outlet of said lake for the purpose of improving the navigation on the Red River of the North,

as provided in section 8 of the river and harbor act of June 3, 1896.

Otter Tail Lake is the lower and principal of a large group of lakes which lie near the head waters of Otter Tail River, one of the principal sources of the Red River of the North. The total area of the tributary watershed is 943 square miles. Of this the wet area comprises 152 square miles and the dry area 791 square miles. We may assume from local observations and experience in the Mississippi reservoir system an average rainfall of 23 inches and an average run-off of 17 per cent from both wet and dry areas. The object will be to control the run-off not only during an average year, but in a maximum year, excepting, of course, the extraordinary. By preventing the waste of this water during flood seasons and putting it into the river at a time when the supply is wholly deficient for the purposes of navigation we may expect to create effects in the way of improvement that are permanent. Stored water is clear water. It will not fill up the channels with sediment, as is the case with flood waters. Being applied at low-water stages, its scouring effect is at a maximum. A river improved by means of reservoirs is permanently improved, and involves a less cost for maintenance of improvements than by any other system.

The total quantity of water which may be collected on this watershed in an average year is 8,544,032,640 cubic feet. To hold this in Otter Tail Lake would require a vertical manipulation over about 12 feet. It will probably be better to use another lake as holding ground in conjunction. The above quantity of water could be liberated as follows: Four hundred cubic feet per second during the open-navigation season of 214 days; 100 cubic feet per second during the closed season of 152 days.

The effects would be substantially as follows:

(1) Make the Red River of the North navigable for a draft of over 2 feet between Breckenridge and Fargo, and over 3 feet from thence to Grand Forks.

(2) Protect the valley of this river over the same reach from destructive floods.

For these reasons I recommend this locality as worthy of improvement.

Very respectfully, your obedient servant,

W. A. JONES,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

[Second indorsement.]

WASHINGTON, D. C., *February 24, 1897.*

Respectfully returned to the Chief of Engineers.

* * * Further surveys for the determination of the upper limits of the reservoir site and the land damages that may be involved in the overflow of low-lying lands will be necessary. I estimate that the same can be made at an expense not to exceed $3,000. * * *

W. A. JONES,
Lieut. Col., Corps of Engineers.

Y 10.

PRELIMINARY EXAMINATION OF RED LAKE AND RED LAKE RIVER, MINNESOTA, WITH A VIEW TO THE CONSTRUCTION OF A DAM WITH LOCKS AT THE OUTLET OF SAID LAKE, FOR THE PURPOSE OF IMPROVING THE NAVIGATION OF THE RED RIVER OF THE NORTH AND SAID RED LAKE RIVER.

[Printed in House Doc. No. 306, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 18, 1897.

SIR: The river and harbor act of June 3, 1896, directs the Secretary of War to cause a preliminary examination to be made at the following locality, viz:

> Red Lake and Red Lake River, Minnesota, with a view to the construction of a dam with locks at the outlet of said lake, for the purpose of improving the navigation of the Red River of the North and said Red Lake River.

The duty of making the examination thus provided for was assigned to the charge of Lieut. Col. W. A. Jones, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, dated February 5, 1897, upon the subject.

The report of Colonel Jones indicates the practicability of constructing a reservoir at this locality; but I am unable, with the data now available, to express an opinion as to the amount of improvement to navigation which would result from the construction of the proposed dam and lock, or the relation of cost to the interests of commerce involved.

I consider the project worthy to the extent of making a survey which will furnish the information necessary for forming an opinion as to the merits of the improvement proposed. It is estimated that such a survey would cost $5,000.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. A. JONES, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
St. Paul, Minn., February 5, 1897.

GENERAL: I have the honor to make the following report of preliminary examination of—

> Red Lake and Red Lake River, Minnesota, with a view to the construction of a dam with locks at the outlet of said lake, for the purpose of improving the navigation of the Red River of the North and said Red Lake River—

made by me in accordance with the provision of section 8 of the river and harbor act of June 3, 1896.

Red Lake has an area of 486 square miles. It lies near the head waters of Red Lake River, a tributary of Red River of the North, in northern Minnesota. Its watershed area is 1,930 square miles. The lake lies in the midst of an extensive pine forest, except that from its shores on the north and northwest a great swamp stretches across to the Canadian boundary. The lake is in two great bodies, connected by a narrow strait. The greatest length is 50 miles. The width and length of both bodies are nearly alike, being about 12 and 25 miles, respectively. The main body is very shallow on south side.

On account of the marsh conditions on north side the lake can not be raised to advantage more than 2 feet. On the other hand, it can be lowered about 2 feet by excavation at the outlet. This will enable a storage capacity which may be roughly estimated as sufficient to carry the maximum rainfall of two years. The region being wholly unsettled there are no rainfall measurements at hand as a basis for discussion, but we have the observations of the reservoirs in the Mississippi basin for comparison. From these we may assume an average annual rainfall of 23 inches, and an average run-off from wet and dry areas of 17 per cent. This would indicate an average annual run-off for storage of 17,500,000,000 cubic feet. This would admit supplying the river approximately thus: Eight hundred cubic feet per second for two hundred and fourteen days of open navigation; 200 cubic feet per second for one hundred and fifty-two days closed to navigation.

The effect of this regulation of the water supply may be summed up as follows:

(1) The creation of a water line of transportation extending from Thief River Falls to the head of Red Lake, a distance of 84.6 miles on the river and 50 miles on the lake. From the east end of Red Lake a canal can be very cheaply cut through to Rainy River—a marsh covers the whole distance—thus opening a great stretch of country bordering a navigable river, including the Lake of the Woods.

(2) The permanent improvement of the Red River of the North from Grand Forks to the international boundary giving a navigable depth of over 4 feet.

(3) The complete protection of the valley of lower Red Lake River from floods, and the same also to a considerable degree for the valley of the Red River of the North below Grand Forks.

For the foregoing reasons, and the fact that the reservoir can be created by constructing a short, low dam at the outlet of Red Lake at a very small expense, I recommend this locality as worthy of improvement. A survey can be made at a cost of $5,000.

Very respectfully, your obedient servant,

W. A. JONES,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

APPENDIX Z.

IMPROVEMENT OF MISSOURI RIVER AT AND ABOVE SIOUX CITY, IOWA, AND OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

REPORT OF CAPT. J. C. SANFORD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Missouri River between Stubbs Ferry, Montana, and lower limits of Sioux City, Iowa.
2. Removal of snags and other obstructions in Missouri River, above Sioux City, Iowa.
3. Yellowstone River, Montana and North Dakota.

UNITED STATES ENGINEER OFFICE,
Sioux City, Iowa, July 17, 1897.

GENERAL: I have the honor to transmit herewith reports upon the works of this district for the year ending June 30, 1897.

Very respectfully, your obedient servant,

J. C. SANFORD,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Z 1.

IMPROVEMENT OF MISSOURI RIVER BETWEEN STUBBS FERRY, IN MONTANA, AND THE LOWER LIMITS OF SIOUX CITY, IOWA.

The river and harbor act of June 3, 1896, contains the following items of appropriation for work between Stubbs Ferry and Sioux City, exclusive of snagging:

> Improving the Upper Missouri River between Stubbs Ferry, in Montana, and the lower limits of Sioux City, Iowa, two hundred and twenty thousand dollars, of which, in the discretion of the Secretary of War, fifty thousand dollars may be expended in the protection and completion of the works at Sioux City; fifty thousand dollars, or so much thereof as may be necessary, for the protection of the caving bank from a point three hundred feet above the upper to the lower revetment already constructed on the South Sioux City front, as recommended in House Executive Document Numbered Forty-eight, Fifty-third Congress, third session; fifty thousand dollars in the rectification of the river at Pierre and Fort Pierre; forty thousand dollars for the protection of Bismarck Harbor and the rectification of the river to prevent erosion of the banks,

and cutting a new channel at or near that point; twenty thousand dollars between the Great Falls, in Montana, and Stubbs Ferry, in Montana: *Provided*, That subject to such conditions as the Secretary of War may prescribe, any person, company, or corporation may construct a dam or dams across said river above Stubbs Ferry, with necessary canal and improvements to develop water power and for other useful purposes; forty thousand dollars at Yankton, and twenty thousand dollars for improvement of river at Elk Point, which shall be immediately available.

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Improving Missouri River at and near Great Falls, Montana, fifteen thousand dollars.

There being a discrepancy between the total appropriated by the first item and the aggregate of allotments prescribed thereunder, it was decided by the Secretary of War under date of September 25, 1896, that the following allotments from the $220,000 appropriated should be made:

Works at Sioux City	$40,000
Protection of caving bank at [South] Sioux City	40,000
At Pierre and Fort Pierre	40,000
At Bismarck	32,000
Between Great Falls and Stubbs Ferry	16,000
At Yankton	32,000
To be reserved at present	20,000
Total	220,000

Between Great Falls and Stubbs Ferry, in Montana.—The present project, adopted November 30, 1894, provides for securing a low-water channel depth of 3 feet from Great Falls to Cascade, 55 miles, and a low-water channel depth of 2.5 feet from Cascade to the canyon next below Stubbs Ferry, 60 miles, at an estimated cost of $165,812.50, of which $82,675 is for work below Cascade, and $83.137.50 for work above Cascade. The project also contains an estimate of $4,500 for annual maintenance. The work provided for below Cascade consists principally of contraction work at shoals, the greater number of which are not far from Great Falls; above Cascade, the work consists mainly of contraction works and removal of rock obstructions. The project contemplates carrying the improvement continuously upstream from Great Falls.

Under this project to June 30, 1896, an obstruction at Great Falls Island had been removed; dams had been built closing the chutes in rear of White Bear, Wickners, Fox, Wescott and Willow islands; and dikes had been built from the upper ends of White Bear and Wickners islands and opposite Fox Island, to contract the channel. All the above localities are within 9 miles of Great Falls. This work was done in 1895 under an allotment of $20,000 made by the river and harbor act of August 17, 1894.

Two of the dikes opposite Fox Island had settled somewhat during the spring rise of 1896.

In addition to the allotment of $16,000 made from the appropriation of June 3, 1896, for work between Great Falls and Stubbs Ferry, it was decided that the $15,000 appropriated by the same act for work "at and near Great Falls, Mont." could also be applied to the general improvement.

Work was resumed in August, 1896, and during the remainder of the season one dike was built out from the upper end of Wescott Island, and a second dike about 900 feet above it, the object of both being to deepen the channel on the shoal at the head of the island. A dike at Griffin Bar, about 12 miles above Great Falls, was begun, but not much progress had been made when work was stopped by ice. Work on this dike was resumed in April, 1897, since which time the dike has been completed and a large quantity of rock quarried for use on a second dike to be built a short distance above the first. The dikes at Fox Island were repaired in April, 1897. A survey, made late in 1896, showed that the dikes at and near the head of Wescott Island had already had a decided effect on the shoal. During the present spring the river has remained at so high a stage that a survey to show low-water conditions could not be made. The works constructed in 1895 have for the most part stood well, and are producing the desired effect on the shoals.

A small towboat being necessary for carrying on the work, and it being often difficult and sometimes impossible to hire a proper boat, plans were prepared last winter for the construction of a boat, 60 by 14 by 2½ feet, with Scotch marine boilers, 60 inches by 8 feet, and slide-valve engines, 7 by 30 inches. Her hull was constructed in April and May, of oak and Oregon fir. The machinery did not arrive until June, but has now been installed and the boat completed. It is thought that she will render very efficient service.

The work, including the procuring of brush and rock, was done by hired labor.

Maps of the shoals improved during the year accompany this report.

The work has been in local charge of Assistant Engineer W. H. Wood, whose report is appended.

Great Falls to Fort Benton.—No work done or projected.

Fort Benton to Carroll.—The project contemplates deepening and improving the channel by the removal of bowlders, by contraction works on the shoals and by dredging. No work has been done since 1891, navigation having ceased due to the construction of railroads paralleling the river. There was formerly an extensive commerce between lower river points and Fort Benton, nearly all the freight destined for Montana, Idaho, and the British possessions north of these States having been brought by river.

Carroll to Sioux City.—In addition to removal of snags and other obstructions, work of construction or survey has been done during the fiscal year at Bismarck Harbor (646 miles above lower limits of Sioux City), at Pierre and Fort Pierre (369 miles above Sioux City), at Yankton (94 miles above Sioux City), at Elk Point (40 miles above Sioux City), at the Sioux Ice Harbor (just above upper limits of Sioux City), at South Sioux City, and at Sioux City.

At Bismarck Harbor.—Under an allotment of $40,000 made by the river and harbor act of August 17, 1894, for the "protection of Bismarck Harbor and the rectification of the river by works to prevent the river from eroding the bank and cutting a new channel at or near that point," seven dikes were built in 1895 in a bay about three-fourths of a mile above the bridge at Bismarck, where a cut-off was feared. These dikes were of the permeable type, and were intended to build out the shore line by accretion to their outer ends, the latter being approximately on the original shore line. The break-up of ice in March, 1896, considerably injured them, carrying off in all about 560 linear feet of the ends of the dikes. Temporary repairs made in May, 1896, increased the deposit of sand during the flood of the following month, after the subsidence of which a continuous sand bar, 2 to 8 feet above low water, extended from the shore to the line of the then outer ends of the dikes.

The present project provides for expending the $32,000 allotted from the appropriation of June 3, 1896, in repairing these dikes, in building two dikes in continuation downstream of the group constructed in

1895, and in protecting the left bank just below the bridge. This project was approved September 29, 1896. Owing to the lateness of the season and the length of time required for transportation of piling to Bismarck, it was impracticable to make much progress under the project before the river closed. The bracing of the 1895 dikes was, however, repaired, the tops of piles at the outer ends of two of the dikes were sawed off, and a few piles driven deeper. During the winter and early spring two new barges were built and the old plant thoroughly overhauled and repaired.

The spring break-up of ice was of almost unparalleled severity. Heavy gorges formed above and below Bismarck and the water rose to a height of several feet above the banks, covering the bottom with cakes of clear, solid ice over 3 feet in thickness. The 1895 dikes were again badly damaged, though less so than if the piles carried out in March, 1896, had been replaced in the fall, since they would not have been protected by accretion. The lower dike was almost completely destroyed, excepting the foot mattress. The other dikes were all more or less injured, the total length of dike carried away being about 900 feet.

The available funds being insufficient to entirely restore all the dikes to their original length, it was decided to rebuild the lower one, No. 7, using the existing foot mattress, to restore No. 5, and to endeavor to hold the others at their present lengths by building strong T-heads on those whose outer ends had been carried away and by thoroughly repairing the bracing and screening. During this spring the above work on Nos. 7 and 5 has been nearly completed and the repair of the other dikes about one-half completed.

One of the proposed dikes below the group built in 1895 was begun in May. The foot mattress has been completed and sunk, but the completion of the other parts of the work has thus far been prevented by high water.

For the protection of the left bank below the bridge two short dikes, begun in May, have been nearly completed and the bank revetted for 500 feet below the warehouse at the steamboat landing.

A map showing the location of the works accompanies this report.

The work has been done by hired labor and purchase of material. It has been under the local charge of Asst. Engineer H. C. Gould, whose report is appended.

The work done in 1895 and that done and proposed under the present project form part of a general plan for the rectification of the river from 5 miles above to 5 miles below Bismarck, at an estimated cost of $725,000. It is believed, however, that all present requirements will be satisfied without extending the improvement so far below Bismarck.

At Pierre and Fort Pierre.—Under the allotment of $40,000 made by the river and harbor act of August 17, 1894, for "rectification of the river at Pierre and Fort Pierre," five dikes were in 1895 built in front of Fort Pierre to stop the erosion that was in progress at this point. The chute behind Marion Island was closed by a crib-work dam, one dike was built at the Pierre steamboat landing, and a second dike, a short distance below it, carried to a part of its proposed length.

The present project, adopted October 2, 1896, provides for the expenditure of the $40,000 allotted from the appropriation of June 3, 1896, in repairing Marion Island Dam, which had settled considerably at two points, in revetting the right bank from the mouth of Bad River (just below Fort Pierre) to the bluff contact, about 2,830 feet below, in completing the unfinished dike at Pierre, and in protecting the lower portion of the left bank of Marion Island by revetment and short dikes so far as remaining funds would permit. These works, as well as those constructed in 1895, form part of a general plan for the rectification of 7 miles of river in this locality at an estimated cost of $360,000. Under a project adopted July 24, 1896, of which the present one is a modification, the revetment below Bad River and a dike on the Pierre side, 1,700 feet below the incomplete dike above mentioned, were begun early in the fiscal year. Work on the dike was stopped after it had been carried out far enough to cut off a chute that had caused dangerous erosion. The revetment work was continued until the river closed by ice. It was resumed in the spring and has since been completed. During the winter the unfinished dike begun in 1895 at Pierre was completed except the T-head. Repair of the Marion Island Dam was carried on as weather permitted and was completed in March. During the break-up of the ice in the spring the river cut around the island end of the dam, forming a channel 130 feet wide, and necessitating further repairs. The breach has since been closed by a brush and stone dam extending from the island to the old dam, at right angles to the latter.

Two new barges were constructed during the early spring.

Maps showing the location of the works accompany this report.

The work has been done by hired labor and purchase of material. Full details are given in the appended report of Asst. Engineer E. D. Vincent, who has been in local charge.

At Yankton.—A survey of the river from 9 miles above to 1½ miles below the old steamboat landing at Yankton was made in October, 1896. Based on the results of the survey, a project was submitted February 13, 1897, and approved March 23, 1897, for the expenditure of the allotment of $32,000 from the appropriation of June 3, 1896 (less $500 expended on the survey). It provides for protecting and fairing out, by revetment and dikes, the left bank for about 3,400 feet above the site of the proposed bridge (about 3.5 miles above Yankton) and for protecting the left bank by revetment extending downstream from a point about 10,300 feet above the site of the bridge as far as the available funds, less cost of necessary plant, will permit. Nothing has yet been done under this project beyond the preparation of plans and estimates for construction of the plant necessary for beginning work.

The project forms part of a general plan, submitted at the same time, for the rectification of about 6.5 miles of river in this locality, with a view to restoring the old steamboat landing, in front of which a wide bar had formed, and to controlling the channel in the vicinity of the proposed bridge. There was formerly an important river trade at Yankton. In the last few years this has almost ceased, due largely to the silting up of the landing. At present there are indications of a considerable revival of this trade. Two steamboats are now plying with considerable regularity between Sioux City and points on the river above Yankton that are distant from railroads; and a gasoline boat is building for the same trade. Negotiations are, it is said, now in progress for the transshipment near Yankton to the railroads of cargoes brought by the boats from above. Such transshipment will, under present conditions, require the building of spur tracks to some point on the river bank at which boats can land, probably several miles above Yankton.

The subject of the rectification of isolated reaches, such as that at Yankton, is discussed below, under the heading "Work required."

At Elkpoint.—In October and November, 1896, a survey of the river in this locality was made, extending from 7 miles above to 3 miles below Elkpoint. As this locality differs from the other points on the Upper Missouri for which appropriations have been made, in that the expenditure of the funds available will be of no direct benefit to navigation, and will simply protect property against erosion, it was deemed necessary to ascertain as accurately as possible the value of the property threatened. This was done in January, 1897.

In the value thus obtained was included that of so much of the farm land between Elkpoint and the river, of the town property, and of the railroad property, as lay within a curve of fairly probable erosion.

The results of the survey had shown that to properly improve the reach, giving to the works as full security as is ordinarily obtainable on the Missouri, it would be necessary to begin the work at the bluff contact, 5½ miles above Elkpoint, and to extend it progressively downstream.

The estimated cost of such an improvement, extending downstream so far as to fully protect the town, is $377,300, which is regarded as a greater expense than the ascertained value of property endangered would justify. A project was therefore submitted February 8, 1897, for the expenditure of the $20,000 allotted from the appropriation of June 3, 1896 (less $400 expended for survey), forming part of a general plan for protecting the cutting bank in front of the town, the heading of the works to be placed just above the portion of the bank now being eroded, at an estimated cost of $87,300, with a possible additional cost of $34,500 should the heading be threatened with flanking due to changes in the channel above. The works provided for in this plan would, it is thought, protect the town for a number of years, and might protect it until the channel changed so as no longer to threaten it. Those of the works which are regarded as certainly necessary for the purpose (estimated cost $87,300) are such as would properly form part of a general plan for the improvement of the whole river, provided material changes in the course of the river did not occur prior to its adoption. Those possibly necessary (estimated cost $34,500) could only partially be used in such a plan. It was decided under date of April 2, 1897, that the available funds be retained in the Treasury until Congress has made such additional appropriation for the work as will permit it to be carried on with safety.

As there is no present or prospective river commerce at Elkpoint, as such changes in the channel may occur before the general permanent improvement of the river is undertaken as to render the proposed works useless as a part of that plan, as the works will not in any case benefit navigation until included in an improvement of a long reach of river—at least the distance between two important ports—and as the carrying out of a general plan for improvement in the interests of navigation can be far more economically and advantageously done if done continuously rather than by constructing isolated works and afterwards connecting them, it would appear that in instances of this kind such appropriations made for the protection of certain localities are not advisable and interfere with the general scheme for the improvement of the Missouri River in the interests of navigation.

At South Sioux City.—The Nebraska bank of the Missouri River in front of South Sioux City had been protected for about 4,000 feet upstream from the lower bridge and for about 5,400 feet upstream from the upper bridge by revetments constructed by the owners of the respective bridges. Between these two revetments about 4,270 linear feet of bank was unprotected, and was being rapidly eroded. The present project, adopted July 24, 1896, provides for the expenditure of the funds available from the appropriation of June 3, 1896, in protecting this bank by revetment of woven willow mattress and graded and paved upper bank, and by regrading and paving the upper bank for 300 feet farther upstream, the work to be protected at its upper end by a short pile dike. Work on the revetment was begun in August, 1896, and, including the work on the 300 feet of bank above, was completed in November. The short dike at the head, of exceptionally strong construction, was completed in March, 1897. After the spring break-up several minor repairs were made to the upper bank paving and to the bank above the head of the work. The expenditure of a portion of the balance that remains to the credit of this improvement in construction of plant needed for future work on the South Sioux City side having been authorized, plans and estimates for the necessary plant have been prepared. The above work forms part of a general plan for the improvement of the Sioux City reach from 2¾ miles above the mouth of the Big Sioux River to near the lower limits of Sioux City. The estimated cost for the 5 miles below the Big Sioux River is $400,000.

The work, except the construction of the dike, was done by hired labor and purchase of material. The dike was partly built under informal contract.

A map which accompanies this report shows the location of this work as well as of the other works on the Sioux City reach. Full details of the work done are given in the appended report of Assistant Engineer F. M. Towar.

At Sioux City.—In 1889 a group of nine permeable dikes had been built by the Missouri River Commission to check a dangerous erosion in front of the business portion of Sioux City. They had answered their purpose admirably, but at the outer ends had been somewhat damaged, several bents of piles having been washed out. In the spring of 1895 two short dikes above this group were constructed and T-heads placed on two of the old dikes. In the fall of the same year sixteen dikes were constructed along the bluff at the upper end of the Sioux City front. In the spring of 1896 this latter group had been somewhat damaged by ice. Under a project approved February 10, 1897, for the expenditure of the $40,000 allotted from the appropriation of June 3, 1896, the screening and bracing of these dikes were repaired early in March; but during the ice break-up toward the end of March the group was again quite seriously damaged.

A survey of the reach was made in August, 1896.

Under a project adopted July 24, 1896, which that of February 10, 1897, replaced, material for the construction of four barges had been ordered. These barges were built during the past spring.

After the unusually heavy rise of March and April last, a second survey of the reach was made, which showed marked changes in the position of the channel. The most noticeable changes are the compression of the two former channels below the lower bridge into one, the building out of the bar from the right bank below the bridge, thus greatly narrowing the channel and forcing it against the left bank, and the excessive depths in this channel close to the left bank. The tendency of the channel to attack the lower dikes of the group constructed in 1889 and the left bank between this group and the bridge was also indicated.

These changes rendered necessary a revision of the project of February 10, 1897. The present project, approved June 10, 1897, provides for expending $25,000 of the available funds in protecting the left bank below the mouth of the Floyd River and for repairing the existing dikes, the balance to be applied to work at such point on the city front as may be afterwards determined. Preparations for beginning work under the project are in progress. A considerable quantity of construction materials purchased under the former project are available for this work.

A map (referred to under the previous heading) showing the location of existing works on the reach accompanies this report.

The work was done by hired labor and purchase of materials. The report of Assistant Engineer F. M. Towar, who was in immediate charge of the work, is appended.

Ice harbors.—The river and harbor act of September 19, 1890, provided funds for the construction of two ice harbors. These have been located at Rock Haven, near Mandan, N. Dak., and on the Big Sioux River, about 1 mile above its confluence with the Missouri. At the beginning of the fiscal year the former harbor had been completed. The latter, known as the Sioux Ice Harbor, had been nearly completed. (For description of the latter, see Annual Report of the Chief of Engineers for 1896, p. 1868. The project for the Rock Haven Ice Harbor is stated in the Annual Report of the Chief of Engineers for 1895, p. 2219. This is the best printed description of this ice harbor.) During the year fourteen steel mooring posts, constructed by James Rees & Sons Co., of Pittsburg, Pa., have been set in concrete at the Sioux Ice Harbor, and the Government land inclosed by a woven wire fence, completing the harbor as proposed.

River survey.—At the beginning of the fiscal year the detailed survey of the river from Fort Benton, Mont., to Sioux City, and the mapping and publication of the results, had been completed. (For a description of the maps see Annual Report of the Chief of Engineers for 1896, p. 1868.)

During the year the published maps on hand have been stored and distributed in accordance with law. Since the removal of the Sioux City office, March 1, 1897, to the new custom-house, the maps have been stored in the latter building.

WORK REQUIRED.

Stubbs Ferry to Great Falls.—To complete the work provided for in the existing project between Great Falls and the canyon next below Stubbs Ferry will require the expenditure of $114,812.50 in addition to funds now available, of which $31,675 will be required to complete the work between Great Falls and Cascade, 55 miles. The latter sum could be advantageously expended in one season. It is thought that its expenditure will result in an increase of the commerce of the "Long Pool," which has hitherto been hampered at low water by the existing shoals. In a second season the work above Cascade could be begun.

Carroll to Sioux City.—For this reach, 1,309 miles in length, no general plan of permanent systematic improvement in the interests of navigation has yet been submitted. It has been estimated by my predecessors, in annual reports for 1895 and 1896, that such an improvement, confining the river to a low-water width of 700 feet, would cost about $40,000 per mile. The expenditure of such an amount per mile seems hardly justified by present commerce or by its probable increase in the near future. The river trade is now small, though at Sioux City and Bismarck an encouraging increase this year appears probable. It is hoped, however, that certain experiments now in progress under the Missouri River Commission will demonstrate the practicability of controlling the river at a much less cost than above estimated. If the cost can be reduced by one-half or more the improvement of certain navigated stretches would, in my opinion, be justifiable. Even the improvement of only the worst places would be of value.

In the meantime the greatest assistance that can be rendered navigation at a justifiable cost is by the work of the snag boats, elsewhere reported. Not less than $50,000 is needed for each year to properly operate the boats. Their service should be continuous during navigation seasons, and not liable to interruption due to failure of appropriations.

The funds appropriated by the act of June 3, 1896, for this portion of the river, with the exception of the appropriation for snagging, were allotted to work at the following localities: Bismarck Harbor, Pierre and Fort Pierre, Yankton, Elkpoint, South Sioux City, and Sioux City. At Bismarck Harbor, Pierre and Fort Pierre, and Sioux City work had been done in the previous year, based in each case on a general plan for the improvement of a considerable reach of river in the vicinity, the work done forming a small fraction of the entire plan; and the allotments for these points from the above appropriation were for continuation of the work under the general plans. The work done in the past year at South Sioux City came under the general plan for the Sioux City Reach. That proposed at Yankton and Elkpoint came under similar general plans, estimated to cost far more than the allotments. All these plans have been so made as to conform to any probable general plan for the rectification of the whole river, but until the works at these isolated points are connected no material increase of navigation can be expected as a result of the work done. The works are undoubtedly of great local benefit, and at points where they protect or restore a steamboat landing or render the passage of bridges less hazardous are to this extent of assistance to navigation.

Appropriations for the protection of isolated localities interfere with the general improvement of the river in the interests of navigation for the reasons that the river can be much more economically improved if the work is carried on systematically and continuously over a long stretch, and that an improved channel of sufficient length to be commercially valuable to navigation can in this way be most quickly obtained.

If it be the intention of Congress to continue the works at the above localities in accordance with the general plans (estimated cost of each stated above), $100,000 can, with advantage to the work itself, be expended in one season at each locality, except Elk Point, viz: Bismarck Harbor, Pierre (both sides), Yankton, and Sioux City (both sides). At Elk Point $67,300, in addition to the funds now available, can be so expended. For the reason that the general plans have not been approved these estimates are not repeated in the money statement below.

Money statement.

July 1, 1896, balance unexpended		$301,994.97
Pro rata reductions to adjust discrepancy, Act June 3, 1896	$50,000.00	
June 30, 1897, amount expended during fiscal year	111,086.24	
		161,086.24
July 1, 1897, balance unexpended		140,908.73
July 1, 1897, outstanding liabilities	$18,742.11	
July 1, 1897, amount covered by uncompleted contracts	10,722.36	
		29,464.26
July 1, 1897, balance available		111,444.26
Amount (estimated) required for completion of existing project:		
Great Falls to Stubbs Ferry		114,812.50
Great Falls to Sioux City		Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899		*31,675.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

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*Between Great Falls and Stubbs' Ferry.

APPROPRIATIONS.

The appropriations and allotments, exclusive of those for snagging, for the Upper Missouri River have been as follows:

1876	$20,000	1886	$60,000
1878	42,500	1888	200,000
1879	60,000	1890	†300,000
1880	43,000	1892	‡150,000
1881	66,000	1894	110,000
1882	*115,000	1895	40,000
1884	140,000	1896	285,000

In addition to the above amounts, about $60,000 from the appropriations for the survey of the river from Fort Benton to the mouth was spent on the part above Sioux City.

Abstract of proposals for labor and material for improving upper Missouri River between Stubbs Ferry, Montana, and Sioux City, Iowa, received and opened during the fiscal year June 30, 1897, by Capt. J. C. Sanford, Corps of Engineers.

Name and address of bidder.	Character of work or supplies.	Date of opening.	Quantity or extent of proposal.	Bid.	Remarks.
		1896.	*Cu. yards.*	*Per cu. yd.*	
R. A. Talbot, South Sioux City, Nebr.	Grading bank of river at South Sioux City, Nebr.	Sept. 10	20,000	$0.075	
Mark Naughton, Sioux City, Iowa.	.....do	....do	20,000	.054	Awarded.
Miller & Keefe, Sioux City, Iowa.	.....do	....do	20,000	.085	
Smith & Betz, Sioux City, Iowa.	.....do	....do	20,000	.069	
Mitchell Vincent, Onawa, Iowa.	.....do	....do	20,000	.0623	
			Cords.	*Per cord.*	
R. A. Talbot, South Sioux City, Nebr.	Willow brush delivered on bank of river at South Sioux City, Nebr.	Sept. 17	2,000	1.60	
McNamara, Miller & Keefe, Sioux City, Iowa.	.....do	....do	2,000	1.48	Do.
Smith & Betz, Sioux City, Iowa.	.....do	....do	1,000 1,000	1.47 1.67	
		1897.	*Cu. yards.*	*Per cu. yd.*	
W. B. Martin, Oahe, S. Dak	Riprap stone delivered on river bank at Pierre.	Apr. 20	5,000	.84	
Cyrus B. Ingham, Pierre, S. Dak.	.....do	....do	2,000 3,000	.83 1.09	
John Hays and Frederick S. Rowe, Fort Pierre, S. Dak.	.....do	....do	5,000	.935	
John C. Hayes, Pierre, S. Dak.	.....do	....do	5,000	.63	Do.
			Cords.	*Per cord.*	
John Hays and J. S. Rowe, Fort Pierre, S. Dak.	Willow brush delivered on river bank at Pierre.	Apr. 20	510	2.23	
John C. Hayes, Pierre, S. Dak.	.....do	....do	2,000	1.27	Do.
Cyrus B. Ingham, Pierre, S. Dak.	.....do	....do	500 1,000 500	2.13 1.71 1.47	
McNamara & Keefe, Sioux City, Iowa.	Willow brush delivered on river bank at Sioux City.	Apr. 7	1,150	1.75	
Mark Naughton, Sioux City, Iowa.	.....do	....do	1,150	1.45	Awarded 575 cords.
Geo. Hall, Sergeant Bluff, Iowa.	.....do	....do	1,150	1.75	

*$2,832.42 of this transferred to work below Sioux City.
†$192,912 of this afterwards allotted to snagging.
‡$161.53 of this afterwards allotted to snagging.

***Abstract of proposals for labor and material for improving upper Missouri River between Stubbs Ferry, Montana, and Sioux City, Iowa, etc.*—Continued.**

Name and address of bidder.	Character of work or supplies.	Date of opening.	Quantity or extent of proposal.	Bid.	Remarks.
		1897.	*Cu. yards.*	*Per cu. yd.*	
Peter C. Miller, Sioux City, Iowa.	Willow brush delivered on river bank at Sioux City.	Apr. 7	1,150	$1.60	Awarded 575 cords.
			1,150	.80	
J. W. Smith and C. F. Bets, Sioux City, Iowa.	.....do	....do ...	1,150	1.45	Do.
			Cu. yards.	*Per cu. yd.*	
Mark Naughton, Sioux City, Iowa.	Riprap stone f. o. b. cars at quarry, United States to furnish transportation.	Apr. 7	2,400	.53	
			2,400	1.28	Includes transportation.
			2,400	1.75	
Peter C. Miller, Sioux City, Iowa.	.....do	....do ...	2,400	1.23	Do.
Fowler & Pay, Mankato, Minn.	.....do	....do ...	2,400	.20	
John C. French, Sioux City, Iowa.	.....do	....do ...	2,400	.35	Awarded — lowest after cost of transportation added.
Minnehaha Granite Co., Chicago, Ill.	.....do	....do ...	2,400	1.623	Includes transportation.
			2,400	.375	
Ritchie Simpson, Dell Rapids, S. Dak.	.....do	....do ...	2,400	.44	
T. R. Coughlin, Mankato, Minn.	.....do	....do ...	2,400	.28	
		1896.			
J. C. French, Sioux City, Iowa.	.....do	Sept. 17	7,000	0.345	Bid rejected.
Wm. Handley, East Sioux Falls, S. Dak.	.....do	...do	7,000	1.264	Includes transportation.
			7,000	.284	Bid rejected; informal. Stone bought in open market at $0.284 per cubic yard.
		1897.	*Cords.*	*Per cord.*	
Wm. E. Martin, Mandan, N. Dak.	Willow brush delivered on river bank at Bismarck.	Feb. 16	200	1.90	
			500	1.75	
			500	1.49	
Moser & Ekroth, Mandan, N. Dak.	.....do	...do	300	1.85	Awarded 300 cords.
			800	1.35	
Elias K. Hansen, Mandan, N. Dak.	.....do	...do	500	2.00	
Patrick E. Byrne, Bismarck, N. Dak.	.....do	...do	1,200	1.99	Awarded 900 cords.
			800	1.75	
			Cu. yards.	*Per cu. yd.*	
Northern Pacific Railway Co., St. Paul, Minn.	Riprap stone delivered on river bank at Bismarck.	Mar. 4	3,500	1.25	Awarded 2,500 cubic yards.
Wm. E. Martin, Mandan, N. Dak.	.....do		600	1.50	
			500	1.25	Awarded 500 cubic yards.
			500	1.00	Do.
			500	.80	

List of contracts in force during fiscal year ending June 30, 1897, improving Upper Missouri River between Stubbs Ferry, Mont., and Sioux City, Iowa.

Name and residence.	Character and extent.	Price.	Date of approval.	Date of beginning.	Date of expiration.
		Per cu. yd.	1896.	1896.	1896.
Mark Naughton, Sioux City, Iowa.	Grading 6,565.8 cubic yards of river bank at South Sioux City, Nebr.	$0.054	Oct. 10	Sept. 30	Oct. 20
		Per cord.			
McNamara, Miller & Keefe, Sioux City, Iowa.	Furnishing about 2,000 cords of willow brush at South Sioux City, Nebr.	1.48	Oct. 7	....do ...	[a]Oct. 31
			1897.	1897.	1897.
Patrick E. Byrne, Bismarck, N. Dak.[b]	Furnishing about 900 cords of willow brush at Bismarck, N. Dak.	1.99	April 5	May 2	During working season.

[a] Extended to November 25, 1896.

[b] In force.

List of contracts in force during fiscal year ending June 30, 1897, etc.—Continued.

Name and residence.	Character and extent.	Price.	Date of approval.	Date of beginning.	Date of expiration.
Northern Pacific Railway Co., St. Paul, Minn. *a*	Furnishing about 2,500 cubic yards of riprap stone at Bismarck, N. Dak.	*Per cu.yd.* $1.25	1897. June 8	1897. June 8	1897. Aug. 15
William E. Martin, Mandan, N. Dak.	Furnishing 500 cubic yards.. Furnishing 500 cubic yards of riprap stone at Bismarck, N. Dak.	1.25 1.00	May 6	May 24	June 30
John C. French, Sioux City, Iowa. *b*	Furnishing about 2,400 cubic yards of riprap stone at Sioux City, Iowa.	.85	May 12	Not fixed	Sept. 1
John C. Hayes, Pierre, S. Dak. *a*	Furnishing about 5,000 cubic yards of riprap stone at Pierre, S. Dak.	.63	May 28	May 19	During working season.
John C. Hayes, Pierre, S. Dak. *a*	Furishing about 2,000 cords of willow brush at Pierre, S. Dak.	*Per cord.* $1.27	....do ...	....do ...	Do.
Moser & Ekroth, Mandan, N. Dak. *a*	Furnishing about 300 cords willow brush near Mandan, N. Dak.	1.35	July 3	June 7	Do.
Mark Naughton, Sioux City, Iowa. *b*	Furnishing about 575 cords of willow brush at Sioux City, Iowa.	1.45	June 16	Not fixed	Sept. 1
Smith & Bets, Sioux City, Iowa. *b*	.....do........................	1.45	....do ...	....do ...	Do.

a In force. *b* Work postponed.

COMMERCIAL STATISTICS.

River tonnage between Sioux City, Iowa, and Stubbs Ferry, Mont. (exclusive of live stock).

Year.	Tons.	Year.	Tons.
1887	13,961	1892	15,182
1888	12,895	1893	13.837
1889	16,724	1894	25,151
1890	13,326	1895	21,262
1891	13,065	1896	10,116

NEW LINES OF TRANSPORTATION ESTABLISHED DURING THE FISCAL YEAR 1897.

The steamer *Benton*, formerly plying on the Lower Missouri, arrived at Sioux City in June, 1897, and has entered the trade between Sioux City and points above Running Water up to Chamberlain, S. Dak. (about 260 miles above Sioux City landing). Between Running Water and Chamberlain, a distance of 130 miles, no railroad touches or approaches the river. Up to this date she has made one trip between Sioux City and Wheeler, S. Dak. (188 miles above Sioux City), and is now on her return from a second trip.

A gasoline boat, 94 by 18 by 3 feet, engines 30 horsepower, is now building at Sioux City for the trade between this port and Castalia, S. Dak., 206 miles, and if she is successful her owners intend to build a second similar boat for the same trade.

At Bismarck, N. Dak., a gasoline boat, 121 feet long by 21 feet wide, engines 45 horsepower, was launched late last fall, and has been plying during the spring between Bismarck and Coal Harbor, 81 miles above.

Assistant Engineer H. C. Gould reports that during the present month a colony of 300 Russians has arrived and settled at Mannhaven, a new river town about 78 miles above Bismarck, and that a larger colony is expected to arrive there soon. Their trade will be altogether with Bismarck by river.

Traffic by river reaches.

Year.	River reaches between—	Packages and bulk freight.	Passengers.	Live stock.
		Tons.		*Head.*
1890	Sioux City and Bismarck	9,735	4,822	2,974
	Bismarck and Fort Buford	2,467	184	43
	Fort Buford and Fort Benton	1,124	62	43
1891	Sioux City and Bismarck	10,410	1,749	4,683
	Bismarck and Fort Buford	2,645	130	59
1892	Sioux City and Pierre	2,634	32	6,043
	Pierre and Bismarck	7,247	177	2,315
	Bismarck and Fort Buford	5,301	278	300
1893	Sioux City and Pierre	5,456	12,513	23,137
	Pierre and Bismarck	6,256	137	20
	Bismarck and Fort Buford	2,125	12	2
1894	Sioux City and Pierre	1,491	3,095	9,258
	Pierre and Bismarck	19,171	16,362	41,356
	Bismarck and Fort Buford	4,461	102	1,849
	Great Falls and Stubbs Ferry	28	903	....
1895	Sioux City and Pierre	10,485	....	....
	Pierre and Bismarck	5,136	417	7
	Bismarck and Fort Buford	5,591	8	....
	Great Falls and Stubbs Ferry	50	2,204	....
1896	Sioux City and Fort Yates	2,850	....	670
	Fort Yates and Bismarck Bismarck and Fort Berthold	7,106	283	364
	Great Falls and Stubbs Ferry	500	692	....

List of steamers plying on the Missouri River between Sioux City, Iowa, and Stubbs Ferry, Montana, during the year 1896.

Name.	When built.	Dimensions.			Tonnage.	Manager or owner.
		Length.	Breadth.	Depth.		
		Feet.	*Feet.*	*Feet.*		
Mary E. Bennett	1888	65	14	3	21.71	R. A. Talbot, South Sioux City, Nebr.
Capitola Butt	1885	83.7	23.3	3.3	57.31	Do.
Vint Stillings	1881	131	31.8	4.8	177.47	Selzer Bros., Sioux City, Iowa.
Josie L. K.	1884	60	14	2.5	22.75	A. Larsson, Yankton, S. Dak.
Little Maud	1883	92	20	3.4	58.66	Joseph Leach, Running Water, S. Dak.
Last Chance	1870	98.2	17.8	3	50.47	H. J. King, Chamberlain, S. Dak.
Jim Leighton	1893	119.5	30.16	3.6	57.29	B. F. Horn, Pierre, S. Dak.
Castalia	1892	110	24	3.6	75	B. S. Holmes, Sioux City, Iowa.
Batchelor	1878	178.6	31	4	313	I. P. Baker, Bismarck, N. Dak.
Rosebud	1877	177.4	31.3	4	286.49	Do.
Imelda	1892	90	17	2	30	Do.
Rose	1886	44	10	2.75	Less than 50 tons.	N. Hilger, Helena, Mont.
J. J. Hill	1892	50	10	4.5		J. D. Taylor, Great Falls, Mont.
Minnie	1892	50	10	4.5		J. W. Cornelius, Great Falls, Mont.
Francis	1892	29	7	3		J. Klenetco, Great Falls, Mont.
John H. Bloodgood	1896	120	21	....		I. P. Baker, Bismarck, N. Dak.

Dates of ice closings and openings on the Missouri River above Sioux City, Iowa, 1896–97.

[Continued from page 1895, Report for 1895.]

Locality.	Closing.	Opening.
Montana:		
Townsend	Dec. 4, 1896	Mar. 24, 1897
Great Falls (gauge readings suspended).		
Fort Benton	Nov. 19, 1896	Mar. 25, 1897
Wolf Point (gauge readings suspended).		
North Dakota:		
Fort Buford (gauge readings suspended).		
Bismarck	Nov. 8, 1896	Apr. 5, 1897
South Dakota:		
Pierre	Nov. 9, 1896	Mar. 29, 1897
Running Water (gauge readings suspended).		
Iowa:		
Sioux City	Nov. 12, 1896	Mar. 19, 1897

REPORT OF MR. W. H. WOOD, ASSISTANT ENGINEER.

GREAT FALLS, MONT., *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report of operations on the Missouri River between Stubbs Ferry and Great Falls during the fiscal year ending June 30, 1897:

On August 11, 1896, I received your order to proceed to Great Falls and make a survey of the river from the head of Wescott Island to Great Falls, a distance of about 10 miles, with separate surveys of Griffin Bar, 3 miles above Wescott, and of Thurman Bar, 20 miles above.

I reached Great Falls on August 14, and hired a cook, purchased a few tools, and proceeded to Wescott Island, where the property was stored under charge of a watchman. On the 19th and 20th I made a survey of Griffin on the same lines that Mr. Vincent made his survey in 1894, not knowing then that there were two bad bars in this reach, and so surveying only the upper one. This survey showed the bar to be in very different position in the two years, and also a very great change in the river since the survey of 1880 under Captain Maguire.

On the 22d of August I began the continuous survey from Wescott Island and finished at Great Falls at the head of the rapids on the 31st. It took so long because I had to do the sounding myself and then go over the ground again for the stadia work, a mile or 2 at a time.

On September 2 I took a skiff by wagon to Thurman Bar and made a survey there, returning to camp at Wescott Island on the 3d.

On September 5 I went to Great Falls and met yourself and Colonel Robert, and the 6th and 7th were spent in going up the river on Captain Hamilton's steamboat and returning.

On the 7th you gave orders to resume work under the general project by starting the dike at head of Wescott Island, and at the same time to submit a new project for the expenditure of the two appropriations of $15,000 each, made by the river and harbor bill of June, 1896.

On September 10 work was begun on dike at head of Wescott Island, and for ten days the towing of rock and fascines was done by hand, as no authority had yet been received for the hire of towboat.

On the 18th such authority came, and on the 21st the boat was obtained at $165 per month without crew, and a force put at work, consisting of 36 men, including crew.

This first dike was in shallow water and was all one-tier construction of mats and broken stone, except the head, which was two tiers. This dike was finished October 3, and the one 900 feet above it on the same side was started on the 13th. This work was to be done under the new project, and notice of its approval was not received by me till then. The intervening ten days were spent in getting out fascines and rock ready for work. This dike was all two-tier construction and was finished on the 26th of October.

On the 27th I moved camp to Griffin Bar and began work in quarrying rock and cutting brush, but delayed the actual construction till you arrived on the 31st, when you approved of the proposed location of the two short dikes on the right bank, and work on the lower one was commenced immediately.

The weather now changed to a very unusually low temperature with storms, and on the 10th the river froze up. As I had enough fascines made, I discharged the brush crew and kept on at the quarry.

On the 14th the river was clear of ice, as the chinook wind had blown all the 13th, and work was resumed, but in a few hours the temperature fell again to about zero, and I concluded it was safer to get the rented steamer off my hands. So work was shut down, camp loaded on the barges, and a start made down river. An ice gorge within a quarter of a mile of where I meant to winter forced us to camp out another night, but the next day I reached the point desired, Goodrich Ranch, and got the barges into winter quarters near Wescott Island, where they wintered the year before.

On the 16th I made a trip to town with the steamer and brought up lumber for the storehouse and returned the steamer to town and turned her over to the owner none too soon, as the river closed that night for about a month.

I was still in hopes of making the repairs to the Fox Island dikes. Two or three holes had been cut through the lower dikes, where they had been laid on a dry bar, and a few hundred yards of rock were needed to restore them, so I put a small quarry crew at work getting out rock, expecting the weather to moderate and the river to open, as it usually does. But the weather grew colder instead of warm, and on the 19th I discharged all hands.

While going up the river with you I found there was a sand bar at Griffin, nearly a mile below the first one, and while at work there I made another survey to include this lower one. I also made a resurvey of Wescott Island on October 8, after completion of lower dike, which shows the beginning of the cutting due to this dike alone.

I expected to make a survey this spring of Griffin and Wescott; but the ice went out on a rise, and the water has kept up very high all the spring—too high to make a survey of any use.

When settling up with the owners of the steamboat used last summer, they threatened to raise the price for her for this year; and as we were then paying about 10 per cent of her cost per month, I made some estimates and submitted them to you with the proposal that we build a small towboat, 14 by 60 feet, instead of renting. This plan met your approval, and in January authority was received to build a towboat at a cost of not to exceed $2,200. As soon as I received the first plans for the boat frames I returned to Great Falls and was ready to begin the work as soon as the lumber began to arrive. The materials for construction came very slowly from delays of one kind and another, and, although work began on the hull on April 1, it was not launched until May 12.

On April 1 I hired a small crew and made the repairs of Fox Island dikes. The lower dike took 485 cubic yards of stone and the middle one 210 yards. This stone is not yet evenly spread, but filled on lower edge of dike, as the water was too deep to spread it. A few days' work at low water will finish it.

When this work was done, on April 30, I moved the quarry crew to the Griffin Bar Quarry, and they worked there until the 17th of May, when all the piling ground above water was filled. On the 10th of June, the engines having arrived that day, I floated the hull of the steamer, with a small camp, to Great Falls, and the next day began mounting the engines. The next week the boiler and piping arrived. It was not until the 30th that everything was in place ready for trial. On the next day I took the boat up river, stopping at Goodrich Ranch and loading up the whole camp, which was taken to Griffin Bar, and the steamer returned to Great Falls that night for supplies and coal. The machinery worked fairly well, with one or two bad points that can probably be got in order soon. The speed was all we expected.

Below is a table showing amount of material in the three finished dikes. There are no unfinished ones.

There were about 400 yards of rock quarried at the Griffin Bar Quarry in May, 1897. Also a statement showing the average cost for the season of various items is herewith.

The cost of the dikes was not calculated from these averages, but was the actual cost.

Very respectfully, your obedient servant,

W. H. WOOD, *Assistant Engineer.*

Capt. J. C. SANFORD,
Corps of Engineers, U. S. A.

Details and cost of dikes constructed in the Long Pool above Great Falls, season 1896.

Location.	1. Length over head.	2. Length of stem.	3. Length of head.	4. Crest above low water.	5. Amount of dike by tiers.	
					One-tier.	Two-tier.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
On head of Westcott Island	410	390	90	2½	390	90
900 feet above	496	476	80	2½	....	556
Right bank, Griffin Bar	180	160	80	3	135	110
Total and average	1,086	1,026	250	....	525	756

Location.	6. Linear feet of 20-foot mattress.	7. Number of fascines.	8. Cubic yards of loose rock.	9. Cost per linear foot of mattress laid and covered.	Cost per linear foot of dikes in columns 2 and 3.	Total cost.
On head of Westcott Island	590	569	866	$2.57	$3.46	$1,518.41
900 feet above	1,150	1,115	1,472	1.32	2.73	1,517.62
Right bank, Griffin Bar	355	362	274	2.40	3.55	852.97
Total and average	2,095	2,046	2,612	1.86	3.05	3,889.00
Repairs of Fox Island dikes	....	....	695	....	....	430.00

Average cost of items in dike construction.

		Cents.
Fascines bound and loaded on barge		23.8
Fascines towing to work		12.4
Delivered at work		36.2
Rock quarried and loaded on barge	per cubic yard, loose	58.9
Rock towing to work	per cubic yard	25.4
Per cubic yard, delivered		84.3
Making mats 20 feet wide	per linear foot	12.4
Laying and covering with stone	do	30.5

REPORT OF MR. H. C. GOULD, ASSISTANT ENGINEER.

BISMARCK, N. DAK., *July 3, 1897.*

CAPTAIN: I have the honor to submit the following report of operations on the Missouri River for protection of Bismarck Harbor and rectification of the river in that vicinity during the fiscal year ending June 30, 1897:

At the beginning of the year no work was in progress, as the available funds were expended.

From the appropriation for the Upper Missouri River in the river and harbor bill of June 3, 1896, an allotment of $32,000 was made for work here.

I reported to Lieut. Col. W. A. Jones, U. S. A., then in charge, on July 6, 1896, at St. Paul, Minn., and assisted in the preparation of a project for expenditure of the allotment.

SURVEYS AND MISCELLANEOUS.

I arrived in Bismarck July 12, 1896, established an office in the Bismarck National Bank building, and made preparations for a survey of the river.

The field work of the survey was started July 15 and completed July 31, covering the river from a point 4 miles above the railroad bridge down to Fort Lincoln.

The survey was platted on a scale of 1 inch to 600 feet, and a tracing was made.

Changes in the river made necessary a revision of the project prepared in July, and new estimates, made in accordance with your verbal instructions, were forwarded, with above tracing, on August 15, 1897.

The revised requisition for material and outfit was forwarded August 18, 1897. The project provided for the complete repair of the dikes in bend on west bank above bridge, by replacing the heads on the five lower dikes with larger and stronger structures and rebuilding 300 feet of two-row dike; constructing two new dikes just below the first point above the bridge on west side, and four new dikes on east side near the railroad bridge. Also complete overhauling and repair of the pile driver and old barges, including the old quarter boat barge, and the building of two new barges.

Pending approval of the project, a field map of the recent survey, on a scale of 1 inch to 400 feet, was made, drawings and detailed lists of materials for two new barges were prepared, purchases of outfit, supplies, and fuel for the snag boat were made at various times, under circular notice and bids.

The Bismarck gauge readings from 1891 were copied from the gauge keeper's records, and a hydrograph was plotted for comparison of each year. A new standard cable gauge was placed on the bridge in December, and use of the old gauge dis continued. The gauge was tested by levels and found correct.

During the winter detailed drawings of the two new barges were prepared, lists of articles required for next season's work were revised and arranged for obtaining bids, a thorough inventory of property was taken and copies forwarded.

Specifications for obtaining bids on fuel for the snag boat and pile driver, and for brush, poles, and stone were made up and forwarded.

Bids on fuel for watchman's winter supply were obtained, and fuel was finally ordered from H. R. Lyon, Mandan.

A number of lists of employees were prepared, to comply with civil-service rules.

Bids on wood for snagging and pile driving were opened, and orders in accordance with awards approved by you were sent out.

The use of a tug, the switching of material from Mandan to the river bank, use of cars for stone, engagement of employees, making full-size patterns for parts of barges, and a number of other details for the coming season's work were arranged for.

About 100 tons of ice were cut from the river early in February and stored in a shack at Rockhaven for use of employees during the summer.

PLANT.

Care of property.—At the beginning of the year the plant that had been used in repairs to dikes in May, 1896, consisting of the pile driver, two large and four small barges, was in the river at Rockhaven.

In September, 1896, one of the small barges commenced to leak so badly it was hauled out and placed in the boat yard.

Two old barges that were lying on the bank outside the lines of the Government tract were raised up, ways placed under them, and they were moved about 140 feet to inside the limits of the boat yard. The blacksmith shop and the dredge boiler were moved about 1,000 feet into the yard, and all other property was taken inside the boundary lines.

Preparations for hauling out floating plant were started October 13. About 100 cubic yards of mud deposited during the summer high water on foot of the incline were removed and ways were laid. Three small barges and two large barges were hauled up and back into the yard. The pile driver was hauled to top of the incline. The blocks, tools, lines, and other property were placed in good order and stored for the winter.

NEW PLANT.

A space for building the two new barges proposed was cleared in December in the boat yard near upper end of warehouse at the Bismarck landing.

Lumber for these barges arrived in February, and work on framing the mattress barge was started February 15 with a small force. This barge is 100 feet long, 24 feet wide on top, and 20 feet wide on bottom.

Work on the material barge was started March 1. This barge is 70 feet long, 19 feet wide, 4 feet 5 inches deep, with straight sides.

Both barges have two longitudinal solid bulkheads and are fitted with the usual snubbing posts, kevils, and capstans. Their construction was considerably delayed by cold and stormy weather, but they were finished, calked, and painted by April 7, when the river commenced to break up.

The mattress barge was floated during the ice break-up and the material barge was launched April 16.

A lot of construction material at the Bismarck landing was loaded on these barges. The 70-foot barge was sent to Rockhaven April 17, and the mattress barge was sent to the dikes, Group D, where the weaving platform and ways were put on from April 29 to May 3.

Repair floating plant.—In September the old quarter boat was moved on ways 250 feet to near head of the launching ways, and all the property removed from it to the warehouses. The house and old decking were taken off and the boat raised up on blocks for calking.

Early in April work on this barge was resumed. Nearly all the old oakum was reamed out. Two longitudinal bulkheads of 3 and 4 inch plank were put in, bolted to the old stringers and well drift-bolted; the ends of the bottom plank were sawed off 1 foot on each side; the lower streaks in both gunwales were replaced by new ones; both sides were well drift-bolted throughout and then set in on new ends of bottom plank and thoroughly spiked on. New head blocks and corner rake beams were put in and a new deck laid all over. New snubbing posts, 2 kevils, and a large iron capstan were put in, and 6 hatches cut in deck. Many decayed plank were removed, and a large number of decayed places were patched.

The sides, bottom, and rakes were thoroughly calked and the sides and ends were painted.

This barge was launched May 28.

The barges of the old plant, brought from the upper river in 1893, consisting of two 65-foot barges, a 50-foot barge, and three 40-foot barges, were thoroughly overhauled, weak and broken places were strengthened and patched, timber heads, kevils, hatches, and decks were repaired, and all were well calked, painted, and numbered. The old hoisting engine, taken off the pile driver, was set up on the 50-foot barge.

The 24-foot barge, built in 1895, was calked and painted.

These barges were launched between April 27 and May 4.

The pile driver was painted all over, a hole made in the bow during the ice break-up was repaired; the old hoisting engine was replaced by a new double-cylinder, double-drum engine; the chocks, sheaves, kevils, and entire framework of leads were overhauled; new iron braces bolted at foot of leads, and all placed in good order. A new shaft was provided for the sheaves at top of leads, and the sheaves placed close together.

The driver was launched April 23, machinery connected up, new lines fitted, and outfit placed on board.

Repair buildings and yard plant.—In October the foundation of the watchman's house was repaired.

The blacksmith shop, which was blown down in a storm on June 9, was set up again on a good foundation and the bellows were repaired.

The four barge pumps were thoroughly repaired, also many of the augers, wrenches, cant hooks, pike poles, ice saws, ice tongs, wheelbarrows, and other small tools.

Four large iron tackle blocks, received from the snag boat for use in hauling out boats, were sent to the Mandan railroad shops and thoroughly repaired by bushing worn sheaves, replacing broken sheaves by new ones, and drilling oil holes in the pins.

DIKE REPAIRS.

The repairs made in May, 1896, to the dikes built in 1895 held well during the June rise, and additional losses were very small.

In October the pile driver and barges were moved down from Rockhaven, and some work was done to enable the dikes to better withstand the next ice break-up. At Nos. 1 and 2 the tops of the piles above the timbers in the heads and for some distance toward shore were sawed off. On Nos. 3, 5, and 6 a few broken braces and waling pieces were replaced by new pieces. It was intended to drive the piles lower on outer portions of No. 6, but shoal water prevented the driver from reaching them. At No. 7 an attempt was made to drive the piles lower in the outer 120 feet of the dike, but on removing the timbers a number of the piles came out, and it was found that the water toward the outer end rapidly deepened to 28 feet, and the piles were short ones. Five bents only were driven down and well braced; the remaining piles were removed, as they were too short to drive down far enough in the deep water.

The plant was taken back to Rockhaven October 17, as it was too late in the season to procure materials and start any new work.

In March trenches were cut in the ice around the outer ends and along the sides to near shore at the dikes built in 1895, to prevent lifting of the piles by the ice when the water raised. The length of trench cut was nearly 1,100 feet, width from 1½ to 3 feet, and thickness of ice and icy snow from 3½ to 5 feet.

The winter was unusually severe and the fall of snow unprecedented. Cold weather prevailed to nearly April 1, so, when the river started to rise on March 29 for the break-up, the ice was very thick and but little softened.

Ice started running April 5, but, many gorges resulting, the river here rose to 23.6 feet on the gauge April 7, overflowing the bottom lands, and several heavy runs of ice occurred from between and above the dikes across the adjacent bottom and main railroad track, which was under water from April 6 to April 11. When the gorge at bridge went out, the river fell rapidly and was nearly clear by the next day.

Considerable damage was done to the dikes, but they held much better than could be expected, considering the strain they withstood. About 630 feet was cut off the outer ends of Dikes 1, 3, 4, 5, and 6, nearly all of Dike 7—270 feet—was taken out, and many timbers and piles in the remaining parts were broken.

As the upper three dikes had about accomplished their work and the others had done effective work in filling up the bend, and the funds available were not sufficient for complete repairs to all the dikes, the plan of repairs was changed to include only repair of old screening on Dikes 1 to 6, extend Dikes 5 and 7 to original lengths, which required 690 linear feet of two-row dike with small heads on both, omitting new foot mattress, and placing small heads on present ends of Dikes 1, 3, 4, and 6, all the heads to be partly filled with brush and rock.

Of this work the following was done in May: Repairs to old screening and part of bracing on Dikes 1 to 6; at Dike 5 the piles in the extension, 290 feet long, and in T-head were driven, the wales, braces, and screen poles were put on for 170 feet, and on remaining part only temporary braces were placed, as rising water prevented the permanent work; at Dike No. 6 the piles in T-head were driven and braced temporarily; at Dike No. 7 the pile driving and timbering of the extension, 400 feet long, were finished and pole screen carried out 290 feet, when water came up over the timbers. A part of the new work was put in about 10 feet below its original location on account of stubs of broken piles in the old part.

These repairs could not be finished before June, because the water did not fall as low as usual between the spring break-up and summer rise.

DIKE CONSTRUCTION.

The new dikes finally decided upon were: One, 180 feet long, just below the first point on west side above railroad bridge, to prevent further cutting away of the point and to turn current from the bank below; and two, each 80 feet long, on east side, between railroad bridge and the boat ways of the Benton Transportation Company.

At the dike on west side mooring piles were driven May 6. Weaving of mattress was started on slope at top of bank on May 5. A master weaver of mats had been sent from Sioux City and an entirely new crew was taught the method of weaving, making slow work at first.

The stem and T-mat, 13,700 square feet in all, were finished and ballasted by May 21. The weaving crew worked on ballasting of mat at times when supply of brush failed.

The piling, wales, braces, and pole screen for 80 feet from shore were put in, and the screen was continued 24 feet more to the slope on bank. High water and running drift prevented completion of remainder.

At the dikes on east side 7 mooring piles were driven May 25 and 26. The bank in upper dike was partly graded and weaving was started on May 25. The mattress in the first dike, 9,450 square feet, was finished and ballasted, and work on bank slope was completed by June 4, three days being lost through holiday and stormy weather.

At the lower dike the bank slope was graded May 29. Weaving started on June 4 and finished June 8, 8,250 square feet being woven. The ballasting was done at various times to June 14.

The pile driving on these two dikes, 18 in upper and 20 in lower, was done between June 10 and 15.

The timbering and screening was deferred until after the summer high water.

REVETMENT.

During the spring high water the bank below the warehouse at the Bismarck landing began caving away, and your instructions early in May were to protect this bank by such a length of revetment work as remaining funds would permit.

Pile driving for this work was done June 3 to 5. Two double and one single temporary mooring piles were driven for holding head of mattress till ballasted and 24 piles were driven along the shore, spaced about 20 feet apart, to hold inner edge of mat. Weaving was started June 9 and completed June 19. The first 50 feet was nearly 70 feet wide, and the remainder was 60 feet wide, the length 500 feet, making 30,435 square feet in all. The inner edge is at about 5 feet above standard low water. Ballasting the mattress was completed June 22, using 235.5 cubic yards.

The bank above the mat was evened off, the railroad track near top preventing much grading, and this part was riprapped with stone to an average thickness of 1 foot, using 418.8 cubic yards. This work was finished June 30.

Tables showing details of cost of various classes of work are herewith shown.

The accompanying map shows the location of works referred to in the report and some effects of the dike work.

Very respectfully, your obedient servant,

H. C. Gould, *Assistant Engineer.*

Capt. J. C. Sanford,
Corps of Engineers, U. S. A.

Consolidated cost of dike repairs, all incomplete, made during the fiscal year ending June 30, 1897.

Classification.	Dike 1 D.		Dike 2 D.		Dike 3 D.	
	Quantity.	Cost in item.	Quantity.	Cost in item.	Quantity.	Cost in item.
Fir lumber ($0.0117 per foot) . feet, B. M.	110	$1.29	252	$2.95	....	....
Bolts, washers, spikes, etc . . . . . pounds	26	.55	45	.94	42	$0.88
Poles ($3.615 per cord) . . . . . cords	1.975	7.14	3.951	14.28	3.161	11.43
Labor:						
Bracing and screening	....	35.34	....	27.86	....	35.24
Total	....	44.32	....	46.03	....	47.55

Classification.	Dike 4 D.		Dike 5 D.		Dike 6 D.		Dike 7 D.	
	Quantity.	Cost in item.	Quantity.	Cost in item.	Quantity.	Cost in item.	Quantity.	Cost in item.
142 fir piles . . . . . linear feet	....	....	2,851	$481.53	458	$77.36	3,714	$627.29
Fir lumber ($0.0117 per ft.), feet, B. M.	564	$6.60	1,852	21.67	1,676	19.61	7,162	83.80
Bolts, washers, spikes, etc., pounds	46	.97	735	15.43	95	2.00	1,200	25.20
Poles ($3.615 per cord) . . . . cords	6.716	24.28	11.852	42.84	3.16	11.43	8.691	31.42
Labor:								
Pile driving	....	....	....	83.86	....	20.26	....	225.72
Bracing and screening	....	48.12	....	107.83	....	31.49	....	188.32
Fuel for pile driver	....	....	....	10.35	....	2.50	....	20.40
Total	....	79.97	....	763.51	....	164.65	....	1,202.15

Consolidated (bill of) cost of dike construction, incomplete, during the fiscal year ending June 30, 1897.

Classification.	Dike 1 E.		Dike 2 F.		Dike 2 F.	
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
70 fir piles..............linear feet..	963	$162.65	966	$163.15	1,032	$174.30
1,044 feet, B. M., wales and braces, Douglas fir..............	1,044	12.21	....	....	....	....
519,997 cubic yards rock, on barge:						
Northern Pacific Railway Co., cubic yards..............	221.671	334.13	28.194	40.25	....	....
W. E. Martin......cubic yards..	43.963	66.36	101.726	164.21	124.443	177.88
Towage..............	....	....	....	37.50	....	32.65
381.494 cords brush, delivered on barge at work, at $1.99......cords..	229.605	456.91	96.365	191.77	55.524	110.49
44.086 cords brush, delivered on barge at work, at $1.934 ....cords..	....	....	....	....	44.086	85.26
8 cords poles, on barge at work, at $3.59..............cords..	8	28.72	....	....	....	....
1,880 pounds three-eighths inch strand..............pounds..	580	18.21	545	17.11	755	23.71
252 pounds screw and drift bolts, spikes, and washers......pounds..	252	5.30	....	....	....	....
Labor:						
Pile driving..............	....	67.74	....	48.26	....	25.69
Weaving and sinking..............	....	568.11	....	187.95	....	11.66
Bracing and screening..............	....	42.93	....	....	....	....
Fuel for pile driver..............	....	4.82	....	3.08	....	1.64
Total..............	....	1,767.59	....	853.28	....	743.28

NOTE.—To complete these dikes, 1 E requires piling, timbering, and screening on outer 100 feet, and T-head, making 30 feet more. Dikes 1 F and 2 F require timbering and screening. The lengths to outer side T-head will be, 1 E, 180 feet; 1 F, 60 feet; 2 F, 70 feet.

Cost of 500 linear feet of complete revetment at Bismarck Landing during the fiscal year, June 30, 1897.

Classification and extent.	Cost in item.	Total.
Anchor piles:		
24 pine piles, 1,008 linear feet, at $0.078..............	$78.62	
5 fir piles, 238 linear feet, at $0.155..............	36.89	
Labor—		
Hauling to bank and driving..............	42.34	
Fuel for driver..............	2.70	
Total cost of piling..............	....	$160.55
Cost of 131.2 cords of brush:		
131.2 cords delivered on bank, at $1.35..............	177.12	
Labor, loading on barges..............	32.76	
Towage..............	43.75	
Total cost delivered on work ($1.934 per cord)..............	....	253.63
Cost of 131.05 cords brush delivered on barges at work, at $1.99..............	....	260.79
654.352 cubic yards rock ballast:		
229.868 cubic yards delivered on bank near Rockhaven, at $1.25..............	287.33	
424.484 cubic yards delivered on bank near Rockhaven, at $1..............	424.48	
Loading 654-352 cubic yards on barges..............	194.10	
Towage..............	62.50	
Total cost delivered at work ($1.48148 per cubic yard)..............	....	968.41
Construction of mattress, 500 linear feet, or 30,435 square feet:		
Three-eighths-inch strand, 1,250 pounds, at $0.0314..............	39.25	
Labor, weaving and anchoring..............	413.42	
Total cost ($1.487 per 100 square feet)..............	....	452.67
Ballasting mattress and bank:		
Labor—		
Ballasting mattress..............	26.38	
Smoothing and shaping bank..............	45.98	
Placing rock on bank..............	67.09	
		139.45
Total..............	....	2,235.50

Cost of survey work done during the fiscal year, June 30, 1897.

BISMARCK HARBOR.

Classification.	Cost per item.	Total.
Labor:		
Survey and mapping (head of dikes to Fort Lincoln)	$390.96	
Survey and mapping (miscellaneous surveys and map for annual report)	99.62	
Materials	3.08	
Transportation and meals	34.30	
Total	....	$527.96

Cost of plant during fiscal year, June 30, 1897.

BISMARCK HARBOR.

Classification.	Materials.	Labor.	Cost per item.
Care of plant:			
Watching	....	$610.35	$610.35
Pulling out (seven hulls)	$26.45	176.86	203.31
Launching (eight hulls)	2.40	140.38	142.78
Miscellaneous	16.25	232.12	248.38
Total	45.10	1,159.71	1,204.81
Repairs:			
Yard and office plant (including watchman's house)	14.26	104.00	118.26
Floating plant	171.09	859.96	1,031.05
Total	185.35	963.96	1,149.31
New plant constructed:			
Mattress barge, 100 by 24 by 4 feet 5 inches	512.37	900.66	1,413.03
Material barge, 70 by 19 by 4 feet 5 inches	244.10	581.18	825.28
Total	756.47	1,471.84	2,238.31
New plant purchased:			
One hoisting engine	479.00	....	1,129.15
Rope	291.40		
Three iron capstans	162.00		
Tackle blocks, tools, etc	196.75		

REPORT OF MR. E. D. VINCENT, ASSISTANT ENGINEER.

PIERRE, S. DAK., *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report of operations under my charge on the improvement of the Upper Missouri River at Pierre and Fort Pierre, S. Dak., for the fiscal year ended June 30, 1897:

On July 7, 1896, I proceeded to Pierre, under orders of Lieut. Col. W. A. Jones, to assume charge of the contemplated improvement work at that point; to make a resurvey of the locality; to ascertain the resultant effects of work already constructed, and to determine the extent of the changes in the banks and bed of the stream since the close of the working season of 1896.

A survey was made during July and August and maps drawn of the river immediately in front of Pierre, which covered as much of the reach as would receive attention during the season.

During October another survey was made and maps drawn detailing the entire reach of 7 miles contemplated to be improved. The maps when finished were forwarded to your office at Sioux City, Iowa.

On examination, the pile and crib dikes constructed last season (Group D) were found to be in excellent condition and to have accomplished intended results admirably. In front of Fort Pierre, where the bank had been cutting badly, the system of dike work constructed has caused a protecting bar to form along the entire front of the town and extending nearly out to the T-heads. On the Pierre side of the river above town a short dike had been finished immediately below the boat landing and warehouses, and a second, somewhat longer, started (Group G) but left unfinished by reason of lack of funds. These two constructions, while they are not in themselves enough to materially change the course of the river, have stopped the bank's cutting and have caused bars to form along the adjacent shore.

The crib dam, which had been constructed in the rear of Marion Island, closing a chute 900 feet wide, which had held against the spring break-up of 1896, gave way, or rather sunk, during the flood stage of the river in June. The construction apparently rests on a bed of quicksand, since the scour underneath the foundation mattress caused an uneven settlement of the dam at two places of from 3 to 12 feet. The larger breach, 295 feet in width, occurred adjacent to the main shore, the other, 30 feet wide, immediately under the island bank.

Authority to commence the improvement work at this point under the present allotment was received from your office August 27, 1896. The modified project contemplated the repair of Marion Island Dam; the protection of the river's bank by a revetment construction from the mouth of Bad River to where the bluff closes with the shore line 2,800 feet below; the finishing of Dike 1, Group G; the building of the shore end of Dike 1, Group E, and the protection of as much of the lower end of Marion Island by revetment and dike work as the funds available, after the other work was finished, would permit.

Marion Island Dam has been repaired, the revetment below Bad River finished, Dike 1, Group G, partially so, and the root of Dike 1, Group E, constructed.

The different work is given in detail below.

REVETMENT WORK BELOW BAD RIVER.

The work of revetting the shore line from the mouth of Bad River downstream to where the bluff closes with the river 2,827 feet below was commenced August 27, 1896. The shore line was formerly a cut bank averaging about 11 feet in height; it was exposed to the full force of the current in the main channel, and, consequently, was being undermined and rapidly cut away during the flood stages of the river.

The first approved project provided for the protection of but the first 1,000 feet down from Bad River. The plans were afterwards modified and called for the rectification of the river's front to the bluff below. The revetment work consisted in grading the bank to a slope of 1 on 3 and protecting the same with a woven mattress, varying in width from 52 to 100 feet; the upper edge of the mattress was carried along the bank averaging 4 feet above low-water mark and the remainder sunk to the bottom of the stream with rock. That part of the mattress above water, with the graded bank above, was ballasted to a depth of 6 inches with riprap stone, which was carried to the top of the slope. The general plan of the work was the same as practiced on the river lower down.

The grading was done with teams and scrapers, with a small force of men ahead clearing and grubbing the small timber and undergrowth. A strip was cleared 100 feet wide along the shore, and the dirt from the slope wasted on the bank.

The mattress on the shoulder at Bad River was 100 feet wide, and carried so 250 feet downstream; it was then narrowed to 80 feet and carried at that width to the 1,400 feet station; as the bottom from this last point down proved to be a hard shale, it was narrowed again to 70 feet, and as the work approached the bluff, the narrowing continued, the last 200 feet being 52 feet wide.

The weaving was carried forward continuously from August 27 until November 1, when the river filling with ice closed navigation for the season and shut off supplies of material. The mattress boat was left in position, however, in hopes that the river might again open, but this did not happen, and finally the boat was pulled out and the mattress sunk November 17. The river closed solid the same day. The bank grading was finished to the bluff.

The graded bank above the mattress which had been left unprotected was ballasted during the winter, material being hauled by teams across the ice. Work on the unfinished stretch was resumed the 1st of May. The unprotected graded bank below last season's work had been partially cut away by the spring floods for a distance of 700 feet. It was regraded.

The mattress weaving was completed June 8, and consists of 2,847 linear feet, or 209,748 square feet of mattress, including one lap. The brush consumed amounted to 1,613.88 cords, an average of 0.769 cords per 100 square feet of mattress woven.

The rock ballasting was completed June 17, involving a total expenditure on the 2,847 linear feet of revetment of 3,980.95 cubic yards ballast, an average of 1.408 cubic yards per linear foot of bank protected. The net cost of the revetment complete, as detailed in the appendix (Exhibit A) was $15,266.48, or at the rate of $5.36 per linear foot.

When Bad River broke and went out the 17th of March, cleaning itself of the mud bar which had accumulated in its mouth and deepening the channel, the force of the flood tore the upper and outer edge of the revetment mattress at the shoulder to some extent. The mattress, however, settled to the bottom, and is now covered by a deposit of mud and silt, so that the damage, if any, can not be determined. The revetment proper along the Missouri River front did not suffer from the spring break-up, although the flood stage of the river was considerably higher than usual.

REPAIRING MARION ISLAND DAM.

The work of repairing the breaks in Marion Island Dam, caused by the high water in June, was carried forward intermittently during the winter of 1896–97.

The repair of the main breach, adjacent to the main shore, where the dam had settled unevenly from 3 to 12 feet for a distance of 295 feet, consisted in rebuilding the crib 10 and 12 feet wide to its former level and filling with rock. For a distance of 100 feet from the shore end the sand had deposited on the sunken dam, making it impossible to secure the new construction to the old. This necessitated the weaving of a 45-foot mattress across this part, and the new crib was built thereon. The mattress was also carried along the entire upper side of the break to prevent further undermining of the old work.

At the island side, the breach 40 feet wide immediately under the bank was repaired by rebuilding the crib work to its former level and protecting the graded bank at the root of the dam with a woven mattress 35 by 110 feet.

The work of repairing was finished the latter part of March. The construction material used in repairing the dam was hauled by teams across the ice.

On April 12, during the height of the spring flood, that portion of the dam immediately under the island bank again sank, carrying with it the shore mattress, and allowing the full force of the water confined in the chute to act on the exposed bank. In consequence, that end of the dam was soon flanked by a crescent-shaped gorge 135 feet wide and 16 feet deep.

Also, where the main breach had been repaired under the main shore the sand was scoured out beneath the new mattress, causing the rebuilt crib to settle for 75 feet to an average depth of 3 feet.

During May these damages were repaired; at the flanked end of the dam the break was closed by building a brush and stone construction at right angles to the original dam, extending from the cut bank above down to the end of the old part 110 feet and with a T-head running 20 feet below the line of the old work.

This new dam consists of a series of mattresses extending across the break and each weighted with stone. Mattresses consist of fascines 16 and 20 feet long and 12 inches in diameter. The fascines are laid on three transverse poles, which are bound to three others, placed directly above, by annealed wire ties passing through the fascines. These mattresses were laid and covered in tiers one above the other until the required height of the dam was reached. The lower tier, consisting of 20-foot fascines, extends 4 feet below those placed above, to act as an apron for the overfall.

This new dam has been carried 1 foot above the level of the old work, and is 3 feet above at the bank shoulder.

At the root of the new dam the sand bank has been protected by a 37 by 75 foot woven mattress ballasted with rock.

The cut bank about the shore end has been protected by brush work.

The breach in the dam adjacent to the main shore was again closed by bringing the depression to grade with a new crib.

These last repairs were finished during May, and to date the present June rise has failed to develop any weakness in the new construction. The closed chute is rapidly filling with sand.

The total cost of the repairs on this dam to date is $3,084.18. (Exhibit B.)

DIKE CONSTRUCTION.

Dike 1, Group G.—This dike, which had been left in an unfinished condition at the close of the work in 1896, had had the foot mattress laid and ballasted and a pole crib filled with rock, averaging 4 feet in height, built out 300 feet. During last winter this crib was built up 6 feet above low-water mark and carried out a distance of 486 feet. The intention is to finish with a pile T-head, but the prevailing high water prevented its being done this year.

The cost of this latest dike construction was $449.19. (Exhibit C.)

Root of Dike 1, Group E.—The bank in the vicinity of the root of the proposed Dike 1, Group E, showing a disposition to cut and endangering the city waterworks plant, the root of that dike was constructed last season. It is a pole crib construction, 10 feet wide, filled with stone resting on a 50-foot woven mattress. This construction extends out 170 feet, and while it protects the bank directly in front of the waterworks, there is a liability of its being flanked, owing to the unprotected condition of the shore line above. This dike when finished according to the approved project will be 1,320 feet in length.

The cost of this 170 feet of crib construction for the root of the dike is $894.32, or $5.26 per linear foot. (Exhibit D.)

CONSTRUCTION MATERIAL.

The willow brush for mattress construction was procured from off the bars along the river. The season's work before having consumed about all the desirable material in the immediate vicinity of Pierre, it necessitated a longer haul from base of supplies.

The brush was contracted for, delivered on barges furnished by the Government, who did the towing to place of expenditure.

The towing distance was from 8 to 40 miles. The brush procured along the reach is of an indifferent quality. The total amount used during the season was 1,825.18 cords. Cost delivered, $3,024.38, an average of $1.657 per cord. There was also used 164.24 cords of cottonwood poles, costing, delivered, $609.36, an average of $3.7102 per cord. The rock for ballasting consists of glacial bowlders varying in weight from 15 to 100 pounds. They were gathered from off the prairies in the vicinity of Pierre. They were contracted for, delivered on barges, which were hauled by the Government. The haul by barges was from 3 to 8 miles. During the winter a limited amount of rock was delivered by teams directly on the work, being hauled over the river on the ice. The total amount of riprap stone used during the season was 4,977.60 cubic yards, costing, delivered at points of expenditure, $6,651.45, an average of $1.3363 per cubic yard.

TOWING MATERIALS.

The steamboats *Jim Leighton* and *Last Chance* have been employed alternately in towing material and assisting construction parties on the improvement work at Pierre and Fort Pierre during the season. They have been hired complete with crew and fuel for $30 per day. The latter part of the season the *Last Chance* with crew was employed at the rate of $20 per day, the Government furnishing the fuel. Towing distance for willow brush was from 8 to 40 miles; towing distance for riprap stone, from 3 to 8 miles.

The cost of towing 1,740.48 cords of willow brush from base of supplies to points of expenditure, at the rate of $30 a day for steamboat service, was $690, an average of $0.3964 per cord. The cost of towing 1,838.18 cubic yards riprap stone from points of delivery to work, at the rate of $30 per day for steamboat service, was $585, an average of $0.318 per cubic yard. At the rate of $20 per day, the Government furnishing the fuel, 1,592.99 cubic yards of stone cost $673.26, an average of $0.408 per cubic yard. Where towing to and from the same point, the cost of stone delivered was about 9 cents per cubic yard the cheaper where fuel was furnished the boat.

When running steady, the *Last Chance* consumed about 3 tons of coal per day.

CARE, REPAIR, AND CONSTRUCTION OF PLANT.

The plant used last season, consisting of a steam pile driver on barge and four 19 by 70-foot barges had been hauled out on the bank 1 mile above Pierre, and tools, etc., stored in an adjacent warehouse.

The plant was in care of a watchman and was found in good condition, but the barges required recalking and setting up before being floated.

This was done during September, and the towing barges launched, the pile driver being left ashore. One barge at first was rigged as a mattress boat and used below Bad River; but the long towing distance necessitated its use with the transporting fleet; it was, therefore, removed, and in its place was rigged a ponton construction, consisting of four 8 by 24-foot lighters placed 16 feet apart connected with stringers on which rested a platform with mattress ways.

This manner of mattress boat has given excellent satisfaction; it, being low, is convenient to weave from; it is light and handles easily and does not offer that resistance to the current given by a solid barge lying across the current.

The river filling with ice and closing navigation November 1 caught the fleet out of harbor. By cutting channels two barges were hauled up under the dikes at Fort Pierre, and left in the water for the winter. The others were hauled out on the bank, where caught; one at the lower end of La Framboise Island and the other below the mouth of Bad River. The two left under the dikes were cut clear by dynamite and towed into the mouth of Bad River after that stream had broken in the spring and before the ice moved out of the Missouri River. The barges banked were launched as soon as the river was clear. The fleet was in the care of a watchman during the winter. The cost of care and repair of plant will be found in appendix (Exhibit E).

Plans were drawn during the winter for two additional barges, each 20 by 70 feet; they were constructed during March and April, and were launched with the pile-driver barge early in May. The barges cost, completed, $790.57 each.

Two 20-foot skiffs (and two capstans) were also constructed during the winter.

The cost in detail of the plant constructed during the season will be found in the appendix (Exhibit H).

At present the entire fleet is in the water and under the care of a watchman until work is resumed after the present June rise.

In closing I wish to state that, with the exception of Marion Island Dam, the improvement work on the reach has withstood the annual floods and breakups of the river exceptionally well. The work as far as constructed is accomplishing intended results admirably.

Very respectfully, your obedient servant,

EDWIN D. VINCENT, *Assistant Engineer.*

Capt. J. C. SANFORD, *Corps of Engineers, U. S. A.*

EXHIBIT A.

Cost of 2,827 linear feet revetment below Bad River.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

Clearing and grubbing 2.13 acres ground, at $142.5305	$303.59		
Grading 15,279 cubic yards bank, at $0.1018	1,556.14		
Total cost grubbing and grading 2,827 linear feet, at $0.6578			$1,859.73
816.6 cords willow brush delivered on barges, at $1.13	$922.75		
Towing same to works, at $0.4132	337.50		
Total cost of 816.6 cords of willow brush delivered at works, at $1.5432		$1,260.25	
276.9 cords willow brush delivered on barges, at $1.39	$384.89		
Towing same to works, at $0.4334	120.00		
Total cost 276.9 cords willow brush delivered at works, at $1.8234		504.89	
520.38 cords willow brush delivered on barges, at $1.27	$660.86		
Towing same to works, at $0.3966	206.37		
Total cost 520.38 cords willow brush delivered at works, at $1.6666		867.25	
Total cost 1,613.88 cords willow brush delivered at works, at $1.6311		2,632.39	
Weaving and anchoring to bank 209,748 square feet mattress, at $0.0106, or 2,847 linear feet, at $0.786		2,237.88	
20,568 pounds wire strand, at $2.557 per hundredweight		625.92	
Estimated cost of freight on wire strand		92.21	
Total cost 209,748 square feet mattress, at $0.0262, or 2,847 linear feet, at $1.9313, ready for ballasting			5,488.40
1331.31 cubic yards riprap stone delivered on barges, at $1.255	$1,670.88		
Towing same to works, at $0.3155	420.00		
Total cost of 1331.31 cubic yards riprap stone delivered at works, at $1.5705		$2,090.88	
433.07 cubic yards riprap stone delivered at works, at $1.255		543.51	
302.67 cubic yards riprap stone delivered at works, at $1.67		505.49	
304.7 cubic yards riprap stone delivered on barges, at $1.10	$335.17		
Towing 304.7 cubic yards stone to works, at $0.5009	152.62		
Total cost of 304.7 cubic yards stone delivered at works, at $1.6009		487.79	
1,609.03 cubic yards stone delivered on barges, at 63 cents	$1,013.79		
Towing same to works, including coal ($293.26), at $0.3779	608.26		
Total cost 1,609.2 cubic yards riprap stone delivered at works, at $1.008		1,622.05	
Total cost 3,980.78 cubic yards riprap stone delivered at works, at $1.3187		[illegible],249.72	
Ballasting 236,518 square feet mattress and bank, at $0.0022		513 82	
Ballasting after river falls, estimated cost		232.50	
Total cost of ballasting 2,847 linear feet revetment, at $2.1096			5,996.04
Regrading 1,417 linear feet banks after spring rise and break-up of ice, at $0.2083			295.13
Net cost 2,847 linear feet revetment, including overlap, at $4.7908 per linear foot			13,639.30
Administration, office and miscellaneous			1,627.18
Total cost 2,847 linear feet revetment, at $5.3623 per linear foot			15,266.48

EXHIBIT B.

Cost of repairs to Marion Island Dam.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

Repairing break of 1896:		
96.05 cords willow brush, delivered at works, at $1.4122	$135.64	
Weaving 11,097 square feet mattress, at $0.0191	212.13	
135 cubic yards stone, delivered at works, at $1.042	140.67	
Ballasting 11,097 square feet mattress, at $0.003	33.29	
Total cost 11,097 square feet mattress, woven and ballasted, at $0.0470		$521.73
80.74 cords poles, delivered at works, at $4.1133	$332.11	
173.15 cubic yards stone, delivered at works, at $1.042	180.42	
Building and ballasting 19,765 cubic feet crib, at $0.0138	272.12	
1,220 pounds wire strand, at $2.557 per hundredweight	31.20	
1 keg wire nails, at $2.80	2.80	
100 pounds No. 12 wire, at $1.65	1.65	
		820.30
Grading bank 1,080 cubic yards, at $0.0925		99.94
Total cost repairing break, 320 linear feet, at $4.5062		1,441.97
Cost repairing break of 1897:		
Bank protection, island and dam—		
32 cords willow brush, delivered at works, at $2.484	$79.48	
Weaving 2,960 square feet mattress, at $0.0198	58.63	
70 cubic yards stone, delivered at works, at $2.1227	148.59	
Ballasting 2,960 square feet mattress, at $0.00676	20.00	
Grading 177 cubic yards bank, at $0.0827	15.13	
1,090 pounds wire strand, at $2.557 per hundredweight	27.87	
Total cost 80 linear feet bank protection, at $4.3712		$349.70
Brush and stone wing dam—		
24.3 cords poles, delivered at works, at $3.2828	$79.77	
144.8 cords willow brush on island, stumpage, at $0.125	18.10	
20.1 cords willow brush, delivered at works, at $1.8174	36.50	
Labor, hauling brush	30.00	
Labor, cutting brush and building dam, 2,768 cubic feet, at $0.1113	318.21	
173.4 cubic yards stone, delivered at dam, at $1.9365	335.79	
625 pounds annealed wire, at $2.46 per hundredweight	15.38	
Total cost of building 130 linear feet brush and stone dam, at $6.4137		833.78
Rebuilding 75 linear feet crib—		
10 cords poles, delivered at works, at $3.2828	$32.83	
37.9 cubic yards stone, delivered at works, at $2.2427	85.00	
Rebuilding and ballasting 2,250 cubic feet crib, at $0.0134	30.25	
Total cost rebuilding 75 linear feet crib, at $1.9744		148.08
Total cost of repairs, 1897		1,331.56
Total cost of repairs season, 1896-97		2,773.53
Administration, office and miscellaneous		310.65
Total cost of repairs		3,084.18

EXHIBIT C.

Cost of additional work on Dike 1, Group G.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

25.47 cords poles, delivered at works, at $3.1366 per cord	$79.89
Building 6,804 cubic feet crib, at $0.0105	71.37
195 84 cubic yards stone, delivered in crib, at $1.255	245.78
270 pounds wire strand, at $2.557 per hundredweight	6.90
Total cost 286 linear feet crib dike, average height 2 feet, at $1.4124 per linear foot	403.94
Administration, office and miscellaneous	45.25
Total	449.19

Exhibit D.

Cost 170 linear feet crib dike at waterworks.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

Waterworks dike:		
Grading bank, 111 cubic yards, at $0.2396		$26.60
Clearing snow from works after storm		13.36
1,425 pounds wire strand, at $2.557	$36.31	
63.15 cords willow brush, delivered at works, at $2.22¼	140.37	
Weaving 8,500 square feet mattress, at $0.01505	127.99	
125 cubic yards stone, delivered at works, at $1.255	156.88	
Ballasting 8,500 square feet mattress, at $0.00235	20.00	
Total cost 8,500 square feet mattress, woven and ballasted, at $0.0566		481.55
23.73 cords poles, delivered at works, at $3.5719	$84.76	
86.53 cubic yards stone, delivered at works, at $1.255	108.60	
Building and ballasting 5,637 cubic feet crib, at $0.0158	89.37	
Total cost of 5,637 cubic feet crib, at $0.0502		282.73
Net cost building 170 linear feet crib dike, at $4.7308, with woven mattress foundation		804.24
Administration, office and miscellaneous		90.08
Total cost 170 feet crib dike, at $5.2607		894.32

Exhibit E.

Cost of plant during year ending June 30, 1897.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

[Construction of plant—Construction of two barges 20 by 70 by 4 feet 4 inches.]

Service account:			
Master carpenter	$97.50		
Ship carpenter and calker	140.70		
Carpenters and mechanics	276.50		
Laborers	175.50		
		$690.20	
Material:			
26,515 feet B. M. Oregon fir, s. 1. s., at $6	159.09		
5,537 feet B. M. Oregon fir, rough, at $4.75	25.30		
		184.39	
12 bales oakum, 600 pounds, at $6.25 per hundredweight	37.50		
100 pounds spun cotton, at $7	7.00		
Iron and spikes	58.87		
Paint	3.18		
		106.55	
Freight on material (estimated)		600.00	
Total cost of two barges		1,581.14	
[Two 20-foot skiffs.]			
Labor	$30.00		
Lumber	29.11		
Hardware	2.00		
		61.11	
Total cost of plant constructed			$1,642.25
Care and repair of plant:			
Watchman			280.65
Labor, recalking and repairing			627.00
Labor, launching and hauling out			750.17
Material used—			
Lumber		$87.22	
Hardware		38.14	
Oakum		43.68	
			169.04
Net cost			1,826.86
Administration, office, and miscellaneous			200.14
Total			2,027.00

Summary of cost of work.

PIERRE AND FORT PIERRE, UPPER MISSOURI RIVER.

Construction of plant, including estimated freight charges	$1,642.25
Care and repair of plant	2,027.00
Marion Island Dam	3,084.18
Water Works Dike	894.32
Dike 1, Group G	449.19
Bad River revetment, including estimated freight charges	15,265.48
Surveys	459.98
Tool and utensil account	56.06
Material on hand, including estimated freight charges	1,773.11
Coal on hand	98.53
Total	25,750.10
Less estimated cost reballasting Bad River revetment	232.50
Total cost, 1896-97	25,517.60

REPORT OF MR. F. M. TOWAR, ASSISTANT ENGINEER.

SIOUX CITY, IOWA, *July 6, 1897.*

CAPTAIN: I have the honor to submit the following report of operations in your district under my charge during the fiscal year ending June 30, 1897:

The operations for the year comprise repairs to the old plant, construction of new, construction of revetment, repair of old dikes, construction of one new one, construction of an ice harbor, surveying, the preparation of projects and maps, estimates of cost of projected works, and necessary miscellaneous office work.

REPAIR OF OLD PLANT.

The plant available for the work at the commencement of the year consisted of one 100-foot mattress barge, three 65-foot barges, one 40-foot barge, and the small steamer *Josie.* The barges, with the exception of the mattress barge, were quite old (having been built in 1885) and greatly in need of repair; but as no funds were available for the construction of new barges at this time, the old ones were pulled out and a skin of 2-inch plank spiked over their entire surface. These repairs made them available for the season's work, and, with small current repairs, they will last several years.

CONSTRUCTION OF NEW PLANT.

The new plant constructed during April and May consists of three barges and a pile-driver hull. Two of the barges are 70 by 20 by 5 feet, one 70 by 19 by 5 feet, and the pile driver is 70 by 20 by 4 feet. The two barges are built with 4-inch gunwales, one 6-inch bulkhead, running longitudinally through the middle of the barge, and two 3-inch bulkheads, one on either side, midway between it and the gunwales. The bottom planks are 3 inches thick and the deck 2 inches; the gunwales and bulkheads are drifted with three-quarter inch bolts every 2¼ feet. The other barge and the pile-driver hull are of similar construction, except in the following particulars: The 3-inch bulkheads are omitted and in their place a row of stanchions put in between the floor timbers and deck beams, mortised into 4 by 6 timbers, running fore and aft, on top of the floor timbers and under deck beams.

The details of cost of plant are shown in Exhibit A.

REVETMENT, SOUTH SIOUX CITY.

This work, to comply with the provisions of the river and harbor act of June 3, 1896, was constructed "for the protection of the caving bank, from a point 300 feet above the upper to the lower revetment already constructed on the South Sioux City front."

The distance covered by the wording of this act is 4,570 feet.

The project, approved July 24, 1896, was for the construction of a revetment over the above-named distance, protected from attack at its upper end by a short pile dike. It was found that the mattress of the upper revetment was in a good state of preservation below ordinary low water, so the construction of the new mattress was commenced at the lower end of this mattress, allowing it to overlap about 10 feet.

The rock for this work was gotten from East Sioux Falls and Rowena, S. Dak., at a cost, delivered in Sioux City, of about $1.03 for 3,528 yards and $1.07 for 6,729 cubic yards. The 3,528 cubic yards were transferred from Sioux City to the work at an expense of 44 cents per cubic yard and the 6,729 cubic yards at 36¼ cents per cubic yard.

On August 18 agreements were entered into for grading 15,000 cubic yards, more or less, at 5¼ cents per yard, and for furnishing 1,000 cords of brush, more or less, at $1.58 per cord. Under these agreements grading was done to the extent of 17,034 cubic yards, and 1,223.57 cords of brush was delivered. Subsequent agreements were afterwards made for the uncompleted part of the bank grading at 5.4 cents per cubic yard and for additional brush required at $1.48 per cord. Under these conditions grading was done to the extent of 6,566 cubic yards, and 1,331.56 cords of brush was furnished.

Operations were commenced on August 18 with a force of one overseer and six men, clearing out drift along the site of the proposed work, cutting and distributing "dead-men" along the bank, to be placed during the progress of the work as anchors for the mattress.

On August 22 grading was commenced and on the 28th weaving and ballasting the mattress. At the end of August little progress had been made; only about 200 linear feet of mattress had been woven and partly ballasted. At the end of September 2,116 feet had been woven and 1,800 feet ballasted. The entire 4,570 feet was completed November 20.

The mattress for the first 700 feet was constructed 100 feet wide, for the next 1,900 feet 90 feet wide, and for the remainder 100 feet wide. The changes in width were made necessary by the conformation of the shore line and the proximity of the deep water in the channel.

The bank was from 13 to 17 feet high and was graded to a slope of 1 on 3, giving a slope of from 40 to 50 feet in width, the mattress being carried up from 10 to 20 feet from the water surface, leaving from 70 to 90 feet of mattress extending out into the river. The mattress was weighted with a covering of about 5 inches of rock and the bank above the mattress paved with rock from 6 inches to 1 foot in thickness, the greatest weight of stone being placed near the junction of the mattress and the paved bank. The mattress was strengthened by three-eighths-inch wire strand woven through it in parallel rows 10 feet apart, both longitudinally and transversely. The longitudinal rows of strand were placed on the under side of the mattress, the transverse on the upper side, the lower strand being drawn up through the mattress at their intersection and the upper strand looped around it, a strong fastening being made at the inner selvage and the strand carried up the slope to the top of the bank, where it was secured to an anchor consisting of a cottonwood log 10 inches in diameter buried 4 feet below the surface of the ground, thus anchoring the mattress to the bank every 10 feet. The new mattress is 4,270 feet long, having an area of 408,000 square feet, covered with an average thickness of 5 inches of rock; the adjacent bank, having an area of about 180,000 square feet, was paved to an average thickness of 10 inches. The whole work required 9,397 cubic yards of rock, 2,411 cords of brush, and about 110,000 linear feet of three-eighths-inch wire strand, giving an average of 2.2 cubic yards of rock, 0.5646 cords of brush, and 25.77 feet of wire strand to each linear foot of revetment. As stated in the foregoing, the new mattress was commenced 300 feet below the point proposed for the head of the revetment because the old mattress covering this part of the reach was found to be in good condition; but the bank over this portion was graded and paved with rock to a thickness of about 8 inches down to the edge of the old mattress. The cost of this revetment is shown in detail in Exhibit B.

DIKE AT HEAD OF REVETMENT.

The dike is 100 feet long, extending out normal to the current, with a T-head 60 feet long at right angles to it. The foot mat to protect the piles from scour was woven after the river had frozen, on ice about 8 inches thick, and was sunk by loading it with rock, until the weight was sufficient to break the ice, commencing at the downstream side and working up; when all but a small portion of the upper side had been sunk a large amount of rock was placed on that part, the mooring cables cut, allowing it to sink to the bottom of the river in proper position.

The stem or main dike consists of two rows of piles 10 feet apart, the piles in the rows being also 10 feet between centers. The T-head contains three rows 5 feet apart, the piles in the rows also 5 feet apart. The upper end of the T-head is V-shaped, with three clusters of three piles each in the outside of the V; the piles in these clusters are lashed together with wire rope. The dike is braced throughout with 6 by 8 inch pine timbers, bolted to the piles with three-fourth inch screw bolts.

The three rows of the T-head have additional braces of pine piles about 14 inches in diameter running their entire length and bolted to each pile in the row with

1-inch screw bolts. The piles in the T-head have a penetration of about 33 feet and are driven in from 9 to 12 feet of water, so that the points are from 42 to 45 feet below the surface. Almost the entire T-head was filled with rock to about low-water surface. This dike stood the heavy break-up last March without damage.

On account of the unexpected closing of the river November 12, the five working barges were frozen in the ice along the work and were pulled out to the top of the revetment. After the break-up in March they were launched and towed to the Sioux Ice Harbor. The cost of this dike is shown in detail in Exhibit C.

DIKE REPAIRS.

It was thought necessary to reinforce the bracing in the T-heads of 14 of the 16 dikes on the upper front of Sioux City before the spring break-up, so diagonal and drop braces were added to the regular square bracing. The break-up was much more severe than usual, and, notwithstanding the strengthening, considerable damage was done to them. The screening, which in some places was slightly broken, was repaired.

The cost of the above repairs are given in Exhibit D.

THE SIOUX ICE HARBOR.

At the end of the last fiscal year the bank had been graded along the whole Government tract, an incline graded for boat ways, and the entire tract plowed, leveled, and seeded. (Report of Chief of Engineers, 1896, p. 1868.)

There was allotted for the project, in addition to the sums already expended for surveys and the purchase, a sum of $3,675. The details of the modified project submitted December 11, 1895, were to grade a suitable incline for laying boatways for a distance of 500 feet along the shore of the Big Sioux River, near the middle of the Government tract, and, above and below the incline, to set mooring posts at intervals of 150 feet, to grade a roadway at a convenient point near the ways to the river, and to suitably fence in the tract owned by the Government. It was also further proposed to clear a channel through the bar at the mouth of the Big Sioux River, at such times as the necessities of the case should require.

As stated in the foregoing, the grading of the incline had been completed during the last fiscal year, but only to the water edge at a 2-foot stage of water, so, if the incline is used at a lower stage, a small amount of grading will have to be done. A woven wire fence on cedar posts was constructed and with necessary gates, inclosing the tract purchased. The mooring posts, fourteen in number, consisting of cylinders of five-eighths-inch steel 15 inches in diameter and 10 feet long, with a cast-iron cap, were set, seven on either side of the incline, at intervals of 175 feet, instead of 150 feet as proposed. They were set in blocks of concrete 3 by 3 by 1 foot, 8 feet below the surface of the ground, and held at the surface by collars of concrete 5 by 5 by 1.5 feet. The cylinders were also filled with concrete. The ice harbor is now complete, but it will be necessary to expend about $600 annually in removing a bar that forms every year at the mouth of the Big Sioux River.

SURVEYS.

A survey of the river in the vicinity of Sioux City, extending upstream from the bridge of the Chicago, St. Paul, Minneapolis and Omaha Railroad Company about 10 miles, was commenced August 18 and completed August 31.

A portion of the river at Yankton, S. Dak., was surveyed, beginning a short distance below the town and extending up about 11 miles. It was commenced October 5 and completed October 24.

The survey of the river near Elk Point, S. Dak., was commenced October 27 and was completed November 17, covering a distance of about 10 miles. The progress of this survey was seriously retarded by the extreme severity of the weather.

The river near Sioux City was again surveyed in April and May. The survey extended from near the south limit of the city to the mouth of the Big Sioux River.

These surveys only included the soundings, bar lines, and main banks of the river, except at Elk Point, where the old slough that runs back to the town was accurately surveyed from where it leaves the present river to where it joins it again.

SLUICING BARS AT MOUTH OF BIG SIOUX RIVER.

On October 17 the snagging steamer *Mandan*, with a small crew, was put in commission to sluice a channel through the bar at the mouth of the Big Sioux River, to make the ice harbor accessible to boats for winter quarters. A fairly good channel to the harbor was completed on the 30th, when the boat was laid up and the crew discharged. The cost amounted to $550.93.

WATER GAUGES.

The following water gauges have been operated during the year:

Townsend, Mont.—This is a standard bridge cable gauge. Reports have been received weekly during the whole year, the gauge being read twice daily. Distance above Sioux City, 1,703 miles.

Fort Benton, Mont.—This is a standard bridge cable gauge. The record is complete for the year.

Bismarck, N. Dak.—This is a standard bridge cable gauge. In December, 1896, a new scale was put on, and since then the readings have been referred to the low water of 1889, instead of reading an approximate elevation above sea level, the data for which was gotten from railroad levels. The record is complete for the year.

Fort Pierre, S. Dak.—The gauge at Fort Pierre is a movable iron cable gauge. Record complete for the year.

Sioux City, Iowa.—By direction of the secretary of the Missouri River Commission, copies of the record have been received weekly during the year.

Hydrographs for each of the above places have been plotted from the records.

Very respectfully, your obedient servant,

F. M. Towar, *Assistant Engineer.*

Capt. J. C. Sanford,
Corps of Engineers, U. S. A.

Exhibit A.

Expenditure on account of plant during fiscal year ending June 30, 1897.

Classification.	Labor.	Material.	Total.
Care and repair of plant:			
Pulling out, repairing and launching 4 barges	$751.32	$221.60	$972.92
New plant constructed:			
Two barges, 70 by 20 by 5 feet; one barge, 70 by 19 by 5 feet; one pile-driver hull, 70 by 18 by 4 feet	1,392.40	1,086.03	2,478.43
Total			3,351.35

Exhibit B.

Cost of 4,270 feet complete revetment at South Sioux City, Nebr., and paving bank over an additional distance of 300 feet, during the fiscal year ending June 30, 1897.

Classification and extent.	Cost in item.	Total.
1,223.56 cords of brush purchased and delivered on bank of river at work, at $1.58 per cord	$1,933.24	$3,729.31
1,213.57 cords of brush purchased and delivered on bank of river at work, at $1.48 per cord	1,796.07	
3,528.55 cubic yards of rock purchased and delivered f. o. b. cars at East Sioux Falls, S. Dak., at 24.9 cents per yard, and 2,437.67 cubic yards from the same place, f. o. b. cars, at 28.4 cents per yard, and 3,859.16 cubic yards from Rowena, S. Dak., f. o. b. cars, at 28.4 cents per yard	2,667.11	
Freight on rock from points of delivery to Sioux City, Iowa	7,336.20	
Transporting 3,452.37 cubic yards of rock on barges from Sioux City across the river to the work, at 44 cents per yard	1,519.04	
Transporting 6,013.01 cubic yards of rock on wagons from Sioux City to work, at 36.5 cents per yard	2,194.73	
Total cost of rock		13,717.08
Grading bank:		
Removal of 17,084 cubic yards of earth, at 5.5 cents	942.37	
Removal of 6,565.8 cubic yards of earth, at 5.4 cents	354.55	
Total for grading		1,297.92
Construction of 408,000 square feet of mattress:		
110,000 linear feet, three-eighths inch wire strand, at 80 cents	880.00	
Weaving and anchoring to bank	5,781.70	6,661.70
Cost per square foot, $0.150.		
Ballasting mattress and bank, 9,405 cubic yards:		
Labor, handling 9,405 cubic yards	3,466.31	3,466.31
Total cost of 4,570 linear feet of revetment		28,872.32
Cost per linear foot, $6,32.		

EXHIBIT C.

Cost of construction of dike 160 feet in length (allowing 60 feet for T-head) at head or South Sioux City revetment.

Classification.	Quantity.	Cost.
55 oak piles .... linear feet..	2,620	$627.21
7 pine piles (used for bracing) .... do....	238	23.80
Norway pine for wales and braces .... feet B. M..	20,832	203.37
Rock delivered on river bank at dike .... cubic yards..	432	615.33
Brush delivered on river bank at dike .... cords..	118	174.64
Screening poles delivered on river bank at dike .... do....	7	17.50
Three-eighths-inch strand for mooring, lashing, and foot mattress.. linear feet..	3,500	28.00
Screw bolts .... number..	240	12.90
Washers, O. G .... pounds..	300	3.30
Labor as follows:		
Pile driving (1,705 feet penetration)	....	637.80
Weaving and sinking mattress, bracing and screening dike	....	527.57
Total	....	2,870.02

EXHIBIT D.

Cost of repairing dikes No. 3 to No. 16 (Sioux City front) during the fiscal year ending June 30, 1897.

Classification.	Quantity.	Cost.
Norway pine for bracing .... feet B. M..	3,674	$78.00
Screw bolts .... number..	400	20.00
Washers .... pounds..	50	.90
Labor, bracing dikes	....	214.67
Total	....	313.57

Z 2.

IMPROVEMENT OF UPPER MISSOURI RIVER BY SNAGGING.

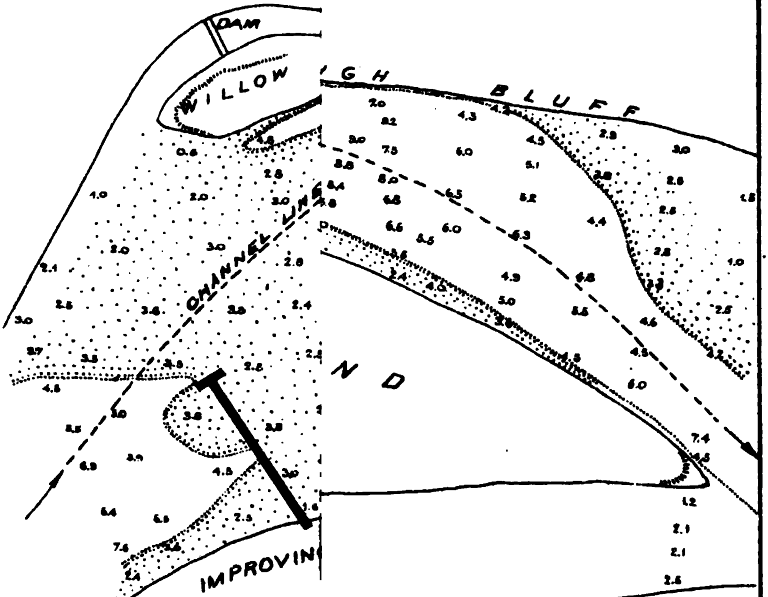
The work of removing snags and other obstructions, and of temporary improvement (to be done by snagging) at the worst bars, in the "sandy river," viz: From Carroll, Mont., to Sioux City, forms part of the project submitted by Capt. Charles F. Powell, Corps of Engineers, September 7, 1891, for the general improvement of the Missouri River between Sioux City and Fort Benton (printed in Annual Report of the Chief of Engineers for 1891, pp. 2248–2249). The estimated cost is $50,000 annually. This work has been carried on since 1891, under allotments from appropriations for the general improvement of the river and under special appropriations. The removal of snags in the river between Great Falls and the canyon next below Stubbs Ferry is provided for in the approved project for that work.

For the work on the sandy river three snag boats, constructed or purchased, are maintained. These are the *James B. McPherson*, steel hull; the *Josephine*, wooden hull; and the *Mandan*, steel hull. All have steam propelling power. (For a full description of these boats, see Annual Report of the Chief of Engineers for 1895, p. 2238.)

The river and harbor act of June 3, 1896, contains the following item of appropriation:

> Improving Upper Missouri River by snagging, fifty thousand dollars.

The project for the expenditure of this appropriation, adopted July 14, 1896, provides for removing snags and other like obstructions in



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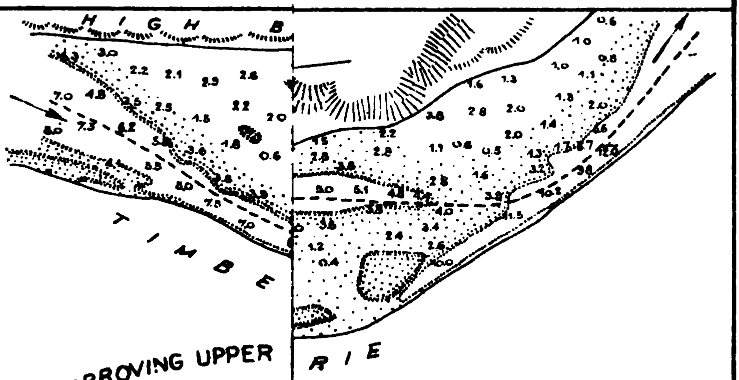

IMPROVING UPPER

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Surveyed Aug. 2

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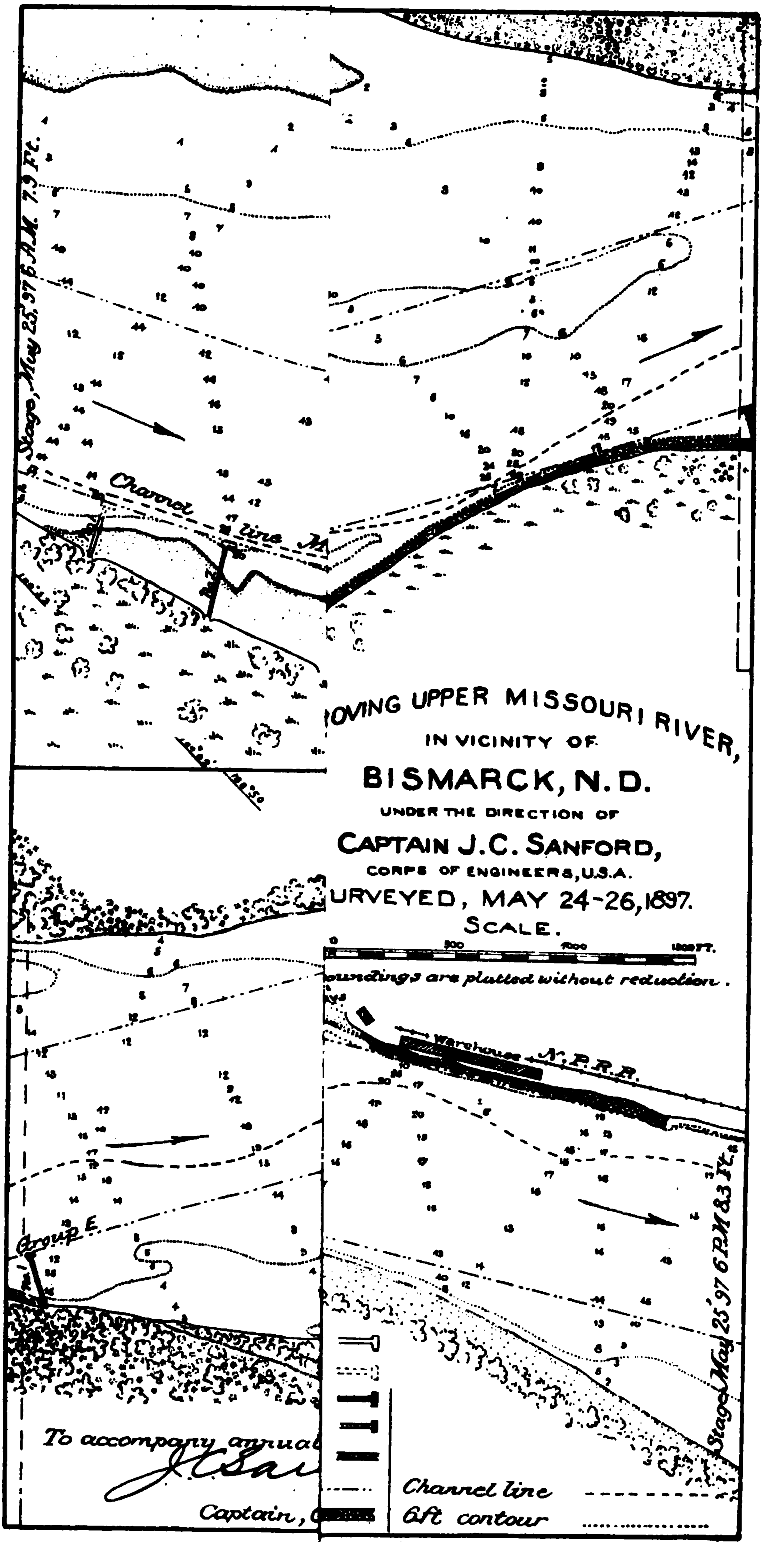
H C Sanford,
Captain, Corps of Engineers, U.S.A.



OVING UPPER MISSOURI RIVER,
IN VICINITY OF
BISMARCK, N.D.
UNDER THE DIRECTION OF
CAPTAIN J.C. SANFORD,
CORPS OF ENGINEERS, U.S.A.
URVEYED, MAY 24-26, 1897.
SCALE.

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To accompany annual

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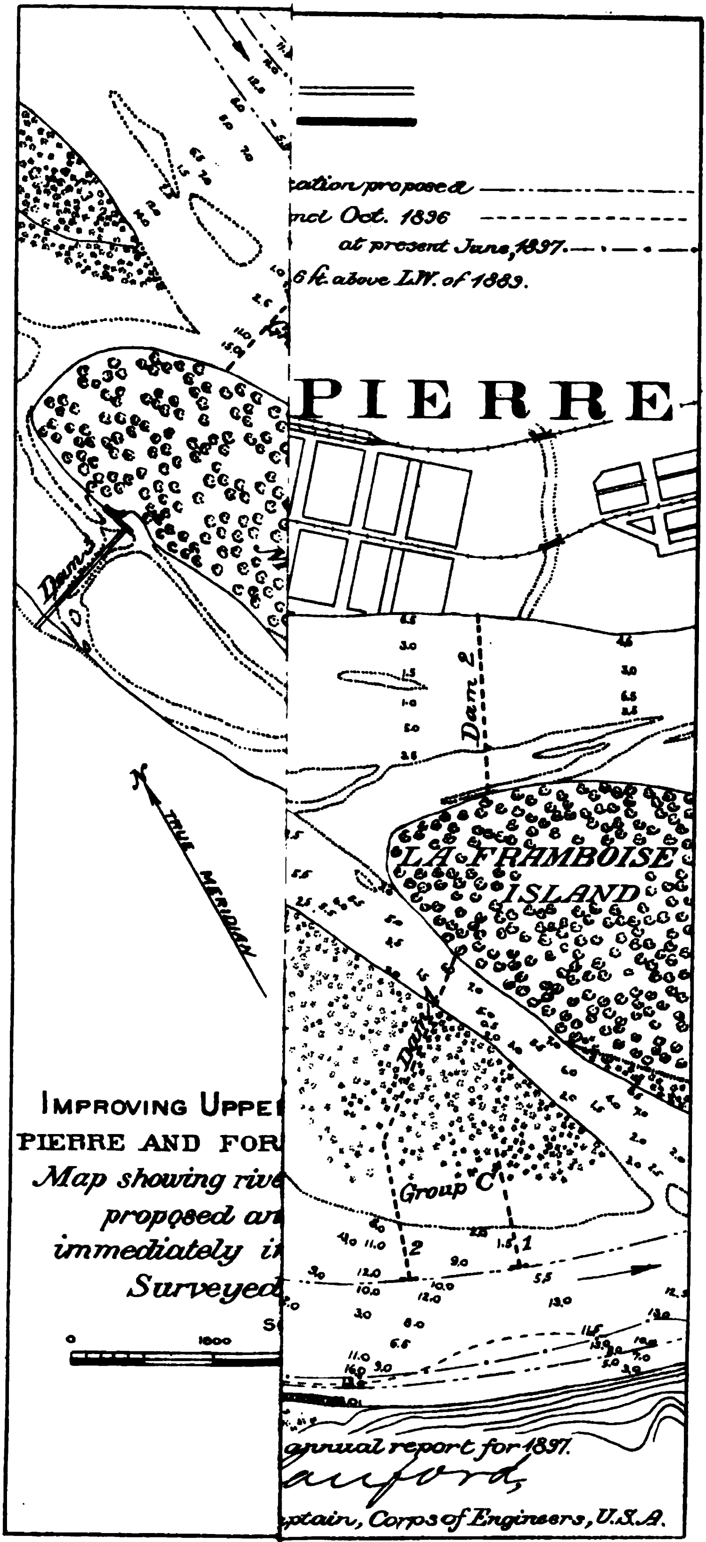
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6 ft. above L.W. of 1889.
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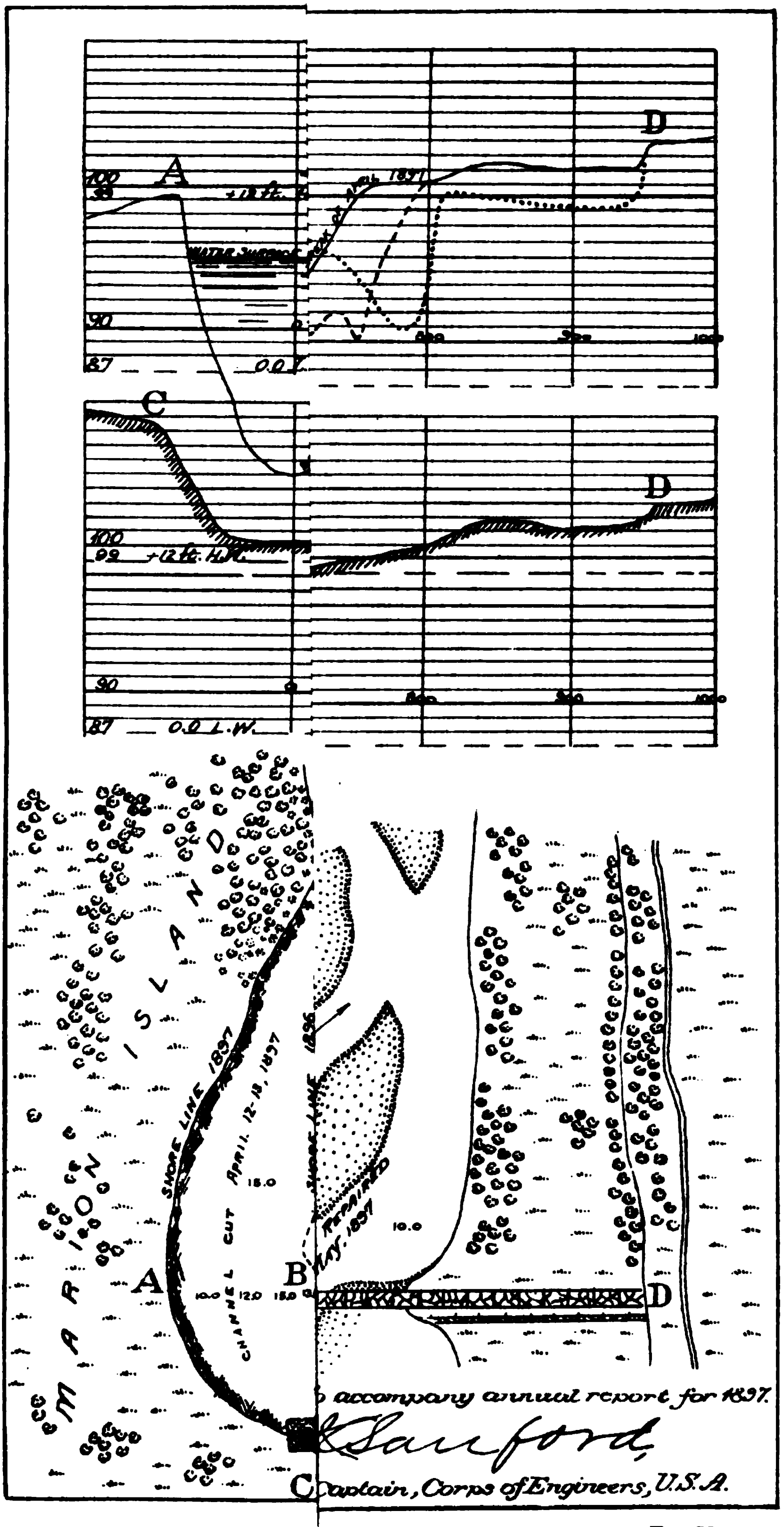

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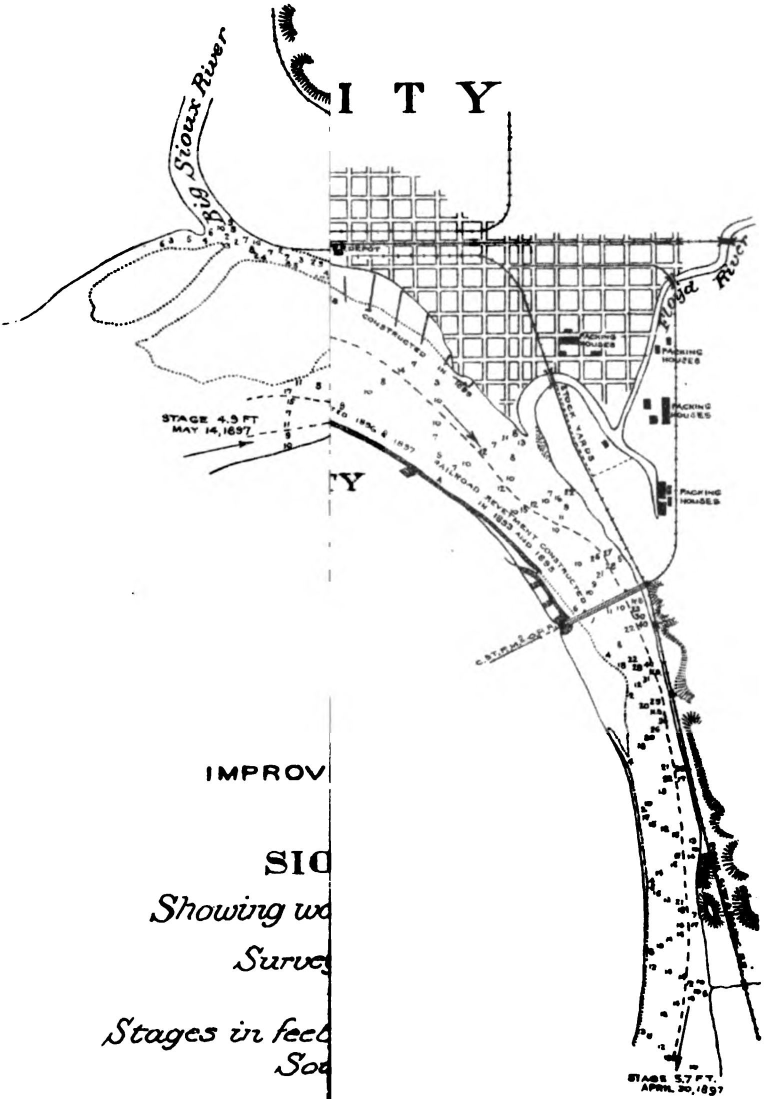
Sanford,

Captain, Corps of Engineers, U.S.A.



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ford,

Corps of Engineers, U.S.A.

the Missouri River between Stubbs Ferry, Montana, and the south limits of Sioux City.

At the beginning of the fiscal year the *Josephine* was at work on the river between Fort Yates and Fort Berthold, N. Dak. The two other boats were laid up at the Sioux Ice Harbor.

During the remainder of the season the *Josephine* worked between Pierre, S. Dak., and Fort Berthold. The *McPherson* was commissioned in August, and worked until the close of the season between Sioux City and Pierre. The *Mandan* was employed for a short time just before the close of the season in sluicing a channel through the bar at the mouth of the Big Sioux River, which obstructed the approach to the ice harbor.

Early in the present spring the *Josephine* left Pierre, where she had wintered, for Sioux City for repairs. On her arrival her crew was transferred to the *Mandan*, which then proceeded to Bismarck, N. Dak., and has since been engaged in snagging work between Fort Yates and Fort Berthold.

Good progress has been made in the repairs of the *Josephine*, which include replacing her boilers by new ones.

Summary of work of boats, July 1, 1896, to June 30, 1897.

Snag boat.	Snags removed.	Snags abandoned.	Trees felled.	Miscellaneous obstructions removed.	Miles run.	
					Up.	Down.
McPherson	250	1	6	19	520	520
Josephine	364	9	1,448	93	967	1,606
Mandan	104	1	1,278	126	1,228	619
Total	718	11	2,732	228	2,715	2,745

The work has been done by hired labor and purchase of material.

By the above work the channel as it existed when worked on has been fairly well cleared of snags; but as the channel is constantly shifting and uncovering old snags, and trees are by erosion of the banks being constantly washed into the river, forming new ones, it can not be said that the river has been kept fully clear of these obstructions. It has been necessary to make the $50,000 appropriated by act of June 3, 1896, cover the expenses of two years' snagging work, as well as of the extraordinary repairs of the Josephine, which were absolutely necessary, so that less than one-half the sum estimated as the least for which the three boats can be continuously operated during navigation seasons and the river kept thoroughly cleared of snags was available for each of the two years' work.

WORK REQUIRED.

The removal of snags and rocks from the channel must form an essential part of any general plan for the improvement of the Missouri River that may be adopted. Until the channel has been absolutely fixed in position by permanent works obstructions will constantly form in the channel, and consequently the work of removing them should be uninterrupted, except as the river is closed by ice. To properly do the work, the 750 miles of river between Sioux City and Fort Berthold should be constantly patrolled by the three snag boats, about one-third of this length of river being allotted to each. To so operate the boats and keep them in repair, not less than $50,000 annually is required. This estimate contemplates also temporary improvement of the worst shoals by sluicing, which can be done by the snag boats. The day when the

Upper Missouri will be permanently improved in the interests of navigation is probably far distant. In the meantime navigation can be greatly benefited by continuous temporary work at a comparatively small cost.

Money statement.

July 1, 1896, balance unexpended		$52,953.05
June 30, 1897, amount expended during fiscal year		27,417.61
July 1, 1897, balance unexpended		25,535.44
July 1, 1897, outstanding liabilities	$5,410.00	
July 1, 1897, amount covered by uncompleted contracts	1,920.00	
		7,330.00
July 1, 1897, balance available		18,205.44
Amount that can be profitably expended in fiscal year ending June 30, 1899. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		50,000.00

Amount and date of all appropriations for improving Upper Missouri River by snagging.

March 3, 1893	$50,000
August 18, 1894	50,000
June 3, 1896	50,000

Abstract of proposals for labor and material for improving Upper Missouri River by snagging, received and opened during the fiscal year ending June 30, 1897, by Capt. J. C. Sanford, Corps of Engineers.

Name and address of bidder.	Character of work or supplies.	Date of opening.	Quantity or extent of proposal.	Bid.	Remarks.
		1897.	*Tons.*	*Per ton.*	
C. A. Burton, Bismarck, N. Dak.	Coal for snag boats, delivered at steamboat landing, Bismarck.	Feb. 3	250	$1.85	Awarded.
Hiram R. Lyon, Mandan, N. Dak.	do	do	250	1.87	
Gillis Bros., New Salem, N. Dak.	do	do	250	2.00	
J. A. Barnes, Bismarck, N. Dak.	do	do	250	2.10	
Fredk. Spencer, sr., Sioux City, Iowa.	Furnishing and setting up two boilers for snag boat Josephine.	Mar. 8		3,717.70	Bid rejected.
Jos. F. Wangler Boiler and Sheet Iron Works Co., St. Louis, Mo.	do	do		2,846.00	Bid rejected; purchased in open market.
	Coal for snag boats, delivered at—				
Brown Coal Co., Sioux City, Iowa.	Sioux City, Iowa	Apr. 15	250 250	2.76 2.74	
	Yankton, S. Dak		20 20	3.85 3.80	
	Running Water, S. Dak.		100 100	4.53 4.30	
	Pierre, S. Dak		200 200	4.59 4.82	Awarded.
L. G. Everist, Sioux City, Iowa.	Sioux City, Iowa	Apr. 15	250	2.58	Awarded.
	Yankton, S. Dak		20	3.80	
	Running Water, S. Dak.		100	4.35	
	Pierre, S. Dak		200	4.59	
W. R. Webb, Sioux City, Iowa.	Sioux City, Iowa	Apr. 15	250	2.70	
	Yankton, S. Dak		20	3.85	
	Running Water, S. Dak.		100	4.45	
	Pierre, S. Dak		200	4.95	
Glenwood Coal and Ice Co., Sioux City, Iowa.	Sioux City, Iowa	Apr. 15	250	2.67	
	Yankton, S. Dak		20	3.50	
	Running Water, S. Dak.		100	4.10	
	Pierre, S. Dak		200	4.65	

List of contracts in force during fiscal year ending June 30, 1897, improving Upper Missouri River by snagging.

Name and address of bidder.	Character and extent.	Price.	Date of approval.	Date of beginning.	Date of expiration.	Remarks.
		Ton.	1897.	1897.	1897.	
C. A. Burton, Bismarck, N. Dak.	Furnishing about 250 tons of lignite coal for snag boat and pile driver at Bismarck, N. Dak.	$1.85	Mar. 26	May 24	Nov. 15	In force.
The Brown Coal Co., Sioux City, Iowa.	Furnishing about 200 tons of Iowa lump coal at Pierre, S. Dak., for snag boats and towboat.	4.59	June 21	June 10	....do ...	Do.
L. G. Everist, Sioux City, Iowa.	Furnishing about 250 tons of Iowa lump coal at Sioux City, Iowa, for snag boats and towboat.	2.58	May 18	June 23	....do ...	Do.

Z 3.

IMPROVEMENT OF YELLOWSTONE RIVER, MONTANA AND NORTH DAKOTA.

Under approved projects for the general improvement of this river, work had been done between 1879 and 1885 between Miles City and the mouth, and a survey of this portion of the river had been made. The project has since been suspended, navigation having ceased. There being a prospect of resumption of navigation this season between Glendive and the mouth, it has been recommended that, in case such resumption is shown to be probable, a portion of the balance remaining to the credit of this improvement be expended in removing snags and other obstructions, and in making an examination of the worst shoals between Glendive and the mouth.

The river and harbor act of June 3, 1896, contains the following item of appropriation:

> Improving Yellowstone River, Montana: Continuing improvement, ten thousand dollars, which sum shall be expended at or near Glendive, Montana.

The project adopted October 16, 1896, for the expenditure of the above appropriation provides for the protection of the caving right bank of the river in front of Glendive for about one-half mile above the bridge, by grading and paving the bank above low-water level.

It being important to do the grading and the lower portion of the paving at as low a stage of the river as possible, work was begun in the latter part of October and was continued through the winter as weather permitted the delivery of rock. It was completed during the present month. The paving extends to a height of 14.5 feet above low water, and was laid with unusual care in order to present a smooth surface to the running ice during spring break-ups.

A map of the locality accompanies this report.

Work was done by hired labor and purchase of material. It was under the immediate charge of Assistant Engineer Bathurst Smith, whose report is appended:

Money statement.

July 1, 1896, balance unexpended	$21,720.41
June 30, 1897, amount expended during fiscal year	9,948.69
July 1, 1897, balance unexpended	11,771.72
July 1, 1897, outstanding liabilities	51.31
July 1, 1897, balance available	11,720.41

Amount and date of all appropriations for improving Yellowstone River.

1878 (allotment for surveys from appropriation for examination and surveys).	$15,000
1879	25,000
1880	15,000
1881	20,000
1882	20,000
1884	20,000
1886	18,750
1896	10,000

Abstract of proposals for material for improving Yellowstone River, Montana, at Glendive, received and opened during the fiscal year, June 30, 1897, by Capt. J. C. Sanford, Corps of Engineers.

Name and address of bidder.	Character of work or supplies.	Date of opening.	Quantity or extent of proposal.	Bid.	Remarks.
		1896.	*Cu. yds.*	*Cu. yds.*	
Arnold Griffin, Glendive, Mont.	Riprap stone at Glendive, Mont.	Dec. 31	2,500	$2.25	Bids rejected. Purchased in open market at $1.60 per cubic yard.
Owen Lovering, Newton, Mont.	.....do	....do	2,500	2.20	
John F. Butler, Glendive, Mont.	.....do	....do	2,500	1.84	

REPORT OF MR. BATHURST SMITH, ASSISTANT ENGINEER.

GLENDIVE, MONT., *July 7, 1897.*

CAPTAIN: I have the honor to submit the following report on the work of improving the Yellowstone River at Glendive, Mont., during the fiscal year ending June 30, 1897:

The object of the work at this point was to prevent the erosion of the river bank at Glendive, by grading it to a slope suitable for revetting, and by paving it to the elevation of average high water. The lower portion of the bank for several feet above low water consists of a hard and tough blue clay or soft soapstone, which erodes slowly.

Above the hard clay is a stratum of gravel, mixed with sand, from 2 to 4 feet thick. Above the stratum of gravel the bank consists of clay and very fine sand, strongly impregnated with alkali. Both the gravel and the bank above cut rapidly when reached by running water.

The cutting of the bank at Glendive is mainly due to a sharp bend in the river just above, which causes the water to flow against the bank at an angle of 60 degrees.

Owing to the firm clay foundation no subaqueous revetment was thought necessary, the lower portion of the paving being made of extra thickness. The revetment was begun at a point 25 feet above the county highway bridge, and continued up the river bank 2,305 feet to the old mouth of Cains Creek, and was carried up the creek 135 feet to prevent flanking.

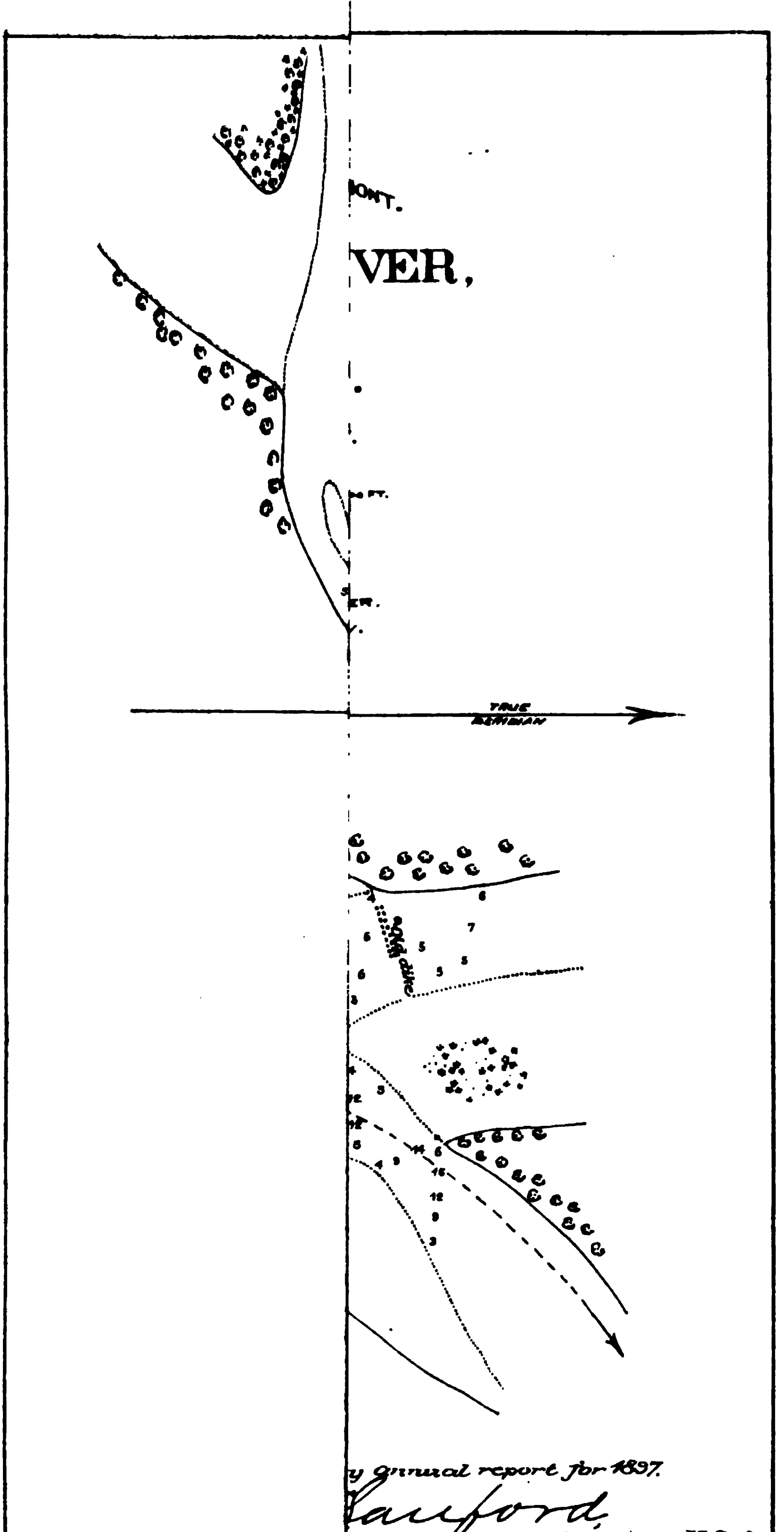
At the bridge and for 1,500 feet above, the bank averages 27.5 feet above low water, sloping down to 13 feet above low water at 1,200 feet above the bridge, and averaging 12 feet above low water the remainder of the distance.

It being thought necessary, in order to complete the work before the June rise of 1897, to put in the lower portion of the revetment with the river at a low stage, I was ordered by you to Glendive, October 24, 1896, and reached that place October 26. Grading was begun October 28, and continued until it was interrupted by a blizzard, November 24, the greater portion being completed.

The soil was found very hard, and it had to be loosened up with a 4-horse plow and with picks before scrapers could be used.

The hardness of the soil, the height of the bank to be graded, and the fact that part of the grading had to be done after the ground was frozen hard, made the grading more expensive than under normal conditions.

In order to push forward the work, an agreement for furnishing 1,200 cubic yards of stone within thirty days, at $1.50 per cubic yard, was made November 9, on ten-day proposals.



y annual report for 1897.

Captain, Corps of Engineers, U.S.A.

The delivery was completed December 22. Formal bids for furnishing the remainder of the stone required for the work were opened December 31. The lowest bid received was $1.84 per cubic yard. This price being considered excessive, it was recommended that all the bids be rejected and the stone be bought in open market.

A written agreement was made February 1, 1897, with Mr. Owen Lovering, to furnish 2,200 cubic yards of stone at $1.60 per cubic yard.

The delivery of stone under this agreement was begun February 15 and was completed June 19.

The paving of the lower portion of the bank was begun November 28, and continued, with some interruption from a rise in the river, until January 16, when work was suspended on account of lack of material.

The river froze over November 11. About December 10 the river rose 4 feet, forcing heavy masses of ice up the graded bank.

The clearing away of this ice, together with the fact that the river remained up 1.5 feet higher than before, made the rest of the foundation work more expensive.

Work was resumed March 3, and continued until March 27, when it was suspended on account of the breaking up of the ice in the river. It was resumed April 17 and continued until completed, June 23.

When the ice in the river broke up, the upper edge of the revetment was 5 feet above low water, except for 700 feet at the lower end, which was 10.5 feet above low water.

The river ran for several days at the rate of 7 to 8 miles per hour, at a stage from 8 to 12 feet above low water, and with heavy runs of ice at intervals.

The break-up had no effect on the work, except to flatten down the upper edge of the revetment and to cut away the graded bank to some extent above the stone.

For 1,840 feet above the lower end the revetment was carried to a height of 14.5 feet above low water, which is, as nearly as could be ascertained, about 2 feet higher than the highest June rise for twelve years, the extra height being added to prevent washing by the waves.

For the remaining 600 feet the revetment was carried to the top of the bank, which averages about 12 feet above low water.

The stone was placed on the bank evenly, and with as smooth a surface as possible, to prevent tearing by the ice.

As completed, the revetment is laid to a slope of about 1 on 2.5, extends up the slope about 35 feet, and averages about 12 inches in thickness. The progress of the work was regulated by the delivery of stone, which was slow, due to the severe winter weather and the poor condition of the roads, and to the fact that there was no one in Glendive equipped for such work, and that the rock in the vicinity of Glendive is of poor quality and has to be carefully selected.

The winter was long and severe, having set in about the first of November and lasting until the last of March.

Over one-half of the work was done during the winter.

The cost of the work was increased by the high price of labor in Glendive and by the necessity of working during the winter in order to complete the work before the June rise. After the completion of the revetment a cable gauge (standard type of Missouri River Commission) was put in on the east span of the bridge.

The cost of the revetment work in detail is shown in Exhibit A attached to this report.

Very respectfully, your obedient servant,

Bathurst Smith, *Assistant Engineer.*

Capt. J. C. Sanford,
Corps of Engineers, U. S. A.

Exhibit A.

Cost of 2,440 linear feet of complete revetment at Glendive, Mont., during the fiscal year ending June 30, 1897.

Classification and extent.	Cost in item.	Total.
1,227 cubic yards of stone, at $1.50 per cubic yard, delivered on river bank	$1, 840. 50	
2,204.9 cubic yards of stone, at $1.60 per cubic yard, delivered on river bank	3, 527. 84	
Total cost delivered on bank, at $1.5642 per cubic yard		$5, 368. 34
Grading bank, 2,440 linear feet, containing 11,800 cubic yards of earth, at $0.1395 per cubic yard: Labor		1, 645. 55
Revetting bank, 3,431.9 cubic yards, at $0.6873 per cubic yard: Labor		2, 358. 80
Total cost of 2,440 linear feet of revetment, at $3.8413 per linear foot		9, 372. 69

APPENDIX A A.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY, AND OF OBION AND FORKED DEER RIVERS, TENNESSEE.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Obion River, Tennessee.
2. Forked Deer River, Tennessee.
3. Cumberland River, Tennessee and Kentucky.

SURVEYS.

4. North fork of Forked Deer River, Tennessee, from Dyersburg to the Obion River.
5. Mouth of Cumberland River, Kentucky.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., July 17, 1897.

GENERAL: I have the honor to transmit herewith the annual reports upon the river improvements in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

A A 1.

IMPROVEMENT OF OBION RIVER, TENNESSEE.

This stream is formed by the junction of the North and South forks in the western part of Tennessee, and flows in a generally southwesterly direction for about 75 miles to the Mississippi. In its course the Obion receives the overflow from Reelfoot Lake, and about 3½ miles from its mouth the waters of the Forked Deer River.

An examination of this stream was made in 1880. (Report of the Chief of Engineers, 1881, pp. 1486–1489.) An instrumental survey was made in 1891 from the railroad bridge at Obion to the mouth of the river, a distance of 68.8 miles, having a fall of 27 feet. (Report of Chief of Engineers, 1891, pp. 2296–2301.)

The project for the improvement, based upon the survey of 1891, and the estimate of $50,000, seeks to secure at low water a navigable channel of not less than 3 feet depth between Obion, Tenn., and mouth of river, about 68.8 miles, by clearing the channel of snags, drift, and overhanging trees; constructing wing dams at the most obstructive shoals; straightening the very crooked channel by cutting through several sharp bends and making the cut-offs sufficiently wide and deep by clearing, grubbing, and excavating; closing the old channel by means of pile and brush dams where necessary.

On June 1, 1897, the above project and estimate were set aside or modified so as to provide simply for the work of removal of such surface obstructions as prevent navigation, and for the maintenance of the channel as improved from year to year, for the reason that it was not considered possible to obtain a depth of 3 feet at low water by the methods proposed in the original project, and that the original estimated cost—$50,000—was wholly inadequate to produce the results called for.

Practically all the work done on this river has been to remove drifts, snags, overhanging trees, etc. The only satisfactory method has been to do the work at extreme low water, cut the trees, limbs and snags, etc., into short pieces and either let them float off, or, if too heavy, drop them in deep holes. Dynamite has also been used to break up snags. Drifts and snags are of course constantly recurring, so that much of the river has had to be gone over again. The clearing of the river has already increased the current somewhat, thus lowering the water surface.

A channel free from snags and trees is all that can be legitimately expected. This will, however, be thoroughly satisfactory to the commercial interests on this river, as the Mississippi keeps it at a good stage for a great part of the year. The lower Obion especially is much affected by the Mississippi River.

During the present fiscal year the channel has been worked over from Obion, Tenn., to the mouth of the river, 68.8 miles. Operations were begun in July, 1896, and suspended September 22, 1896. Between Grindstone Creek and Tiger Tail—mouth of Forked Deer River—distance about 10 miles, the chief work was the removal of trees carried into the channel by the caving in of the banks. Some timber was very large, extending across the channel, and the removal made difficult because of large quantities of sand deposited in around the tree tops. Below the mouth of Forked Deer River, 3.8 miles, from the same cause, that of caving banks, a large number of snags accumulated in the channel, extending in many places to one-third distance across the channel, and standing from 2 feet to 10 feet above low water; the top of these snags were sawed off at about 18 inches below low-water line. The work done consisted of 680 snags and 428 cords of drift removed; 1,896 snags and 37 trees topped; 514 leaning trees cut down; and 491 logs lying along the banks cut up and removed to avoid their being carried into the channel at high water. All work has been carried on by the hired-labor system, the only method upon this stream economical and advantageous to the Government and the work. The total amount expended during the fiscal year ending June 30, 1897, was $1,540.13, in detail, viz:

Pay rolls, works	$979.75
Pay rolls, office	225.00
Subsistence	124.86
Traveling expenses	37.77
Fuel, lights, etc	10.95
Boat repairs	82.60
Tools and repairs	52.23
Explosives	7.90
Transportation and hauling	14.00
Miscellaneous	5.07
Total	1,540.13

The fleet employed for the snagging consisted of two quarter boats and a barge fitted with a steam derrick. At times a small extra barge was used to carry away the snags and logs. The shallowness and narrowness of the channel made the use of a steamboat uneconomical. Before beginning operations the fleet was towed by hired steamer to head of operations and then was floated down while working.

The commerce of this stream consists principally of lumber, which reaches a market on the Mississippi River. Efforts were made to procure data of the shipments during the present fiscal year, but without success. The commerce of the Forked Deer River, however, as reported, passed through the lower waters of Obion River, 3½ miles, in its passage to the Mississippi.

Total amount appropriated	$21,000.00
Amount expended	15,797.01
Amount available	5,202.99

Money statement.

July 1, 1896, balance unexpended	$6,743.12
June 30, 1897, amount expended during fiscal year	1,540.13
July 1, 1897, balance unexpended	5,202.99
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	2,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving Obion River, Tennessee.

Act of—	
July 13, 1892	$7,500
August 17, 1894	7,500
June 3, 1896	6,000
Total	21,000

List of steamboats (stern-wheel) plying on Obion River, Tennessee.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
Clyde	50	14	2.5	10
Gracie	52	11	4.6	34.79
James Laughlin	71.5	15	4.5	28.76

A A 2.

IMPROVEMENT OF FORKED DEER RIVER, TENNESSEE.

I. The Forked Deer River and its navigable branches run wholly in the State of Tennessee, and are tributary to the Mississippi system.

Examinations of these streams have been made as follows:

1. *Of the North Fork and Forked Deer River.*—From Dyersburg to mouth of the main stream, distance about 29½ miles, made in 1873 under act of March 3, 1873. (Report Chief of Engineers, 1874, part 1, pp. 372–380.)

2. *Of the South Fork.*—From Jackson to junction with North Fork, distance about 149 miles; of the North Fork, from Collins to the mouth of Forked Deer River, main

stream, distance about 131 miles, each made in 1880 under act of June 14, 1880. (Report Chief of Engineers, 1881, pp. 1489–1497.)

3. *Of the North Fork below Dyersburg, Tenn.*—Preliminary examination made in 1886 under act of August 5, 1886. (Report Chief of Engineers, 1887, pp. 1494–1495.)

4. *Of the Forked Deer River.*—From Dyersburg, Tenn., to its junction with the Obion River and thence to the Mississippi River, made in October, 1894, act of August 17, 1894. (Report Chief of Engineers, 1895, pp. 2265–2275.)

5. *Survey of the North Fork of Forked Deer River, Tennessee.*—From Dyersburg to the main stream, thence to Obion River, made in November, 1896, under act of June 3, 1896. (House Ex. Doc. No. 282, Fifty-fourth Congress, second session.)

The original condition of channel way, data pertaining to original project and estimates, expenditures and methods of work on the main stream and its navigable branches, are discussed in Report of Chief of Engineers, 1896, page 1901 et seq.

By act of June 3, 1896, $1,000 were appropriated for "maintenance" of the improved channel of the Forked Deer River. Of this amount $985.36 was expended during the present fiscal year upon the South Fork, as approved, removing surface obstructions from the channel for a distance of about 27 miles below Chestnut Bluff. An expenditure of $15.76, balance of old appropriation, was also made in payment of contingent expenses.

The disbursements are classed as follows:

Pay rolls	$830.16	Explosives	$45.75
Traveling expenses	19.25	Tools, rope, etc	2.65
Transportation	7.00	Miscellaneous	15.76
Subsistence	55.35		
Fuel, lights, etc	25.20	Total	1,001.12

An examination of the channel of the South Fork was made in July, 1896, to ascertain what was necessary to be done for maintenance of the improved channel. Operations were begun October 11 and suspended November 24, by reason of exhaustion of appropriation for maintenance. Work done: Nine hundred and ninety snags, 56 stumps and logs, and 391 cords of drift removed; 1,186 snags topped, 598 leaning trees cut down, and 217 logs lying along the banks cut up to prevent their being carried into the channel at high water. The work was carried on in a similar manner, and as a measure of economy, with the same working force, boats, machinery, etc., as that above reported for the Obion River.

The A. M. Stevens Lumber Company, of Dyersburg, Tenn., doing business largely on the North Fork and main stream, in reply to the inquiry "What benefits have been derived from the work done and what are the prospective advantages to be derived by continuing the improvement," states that "the river was navigable between Dyersburg and Mississippi River from January 20 to June 27, 1897, and that it would be very hard to estimate the benefits derived from the work already done on this river. Suffice it to say that if the work had not been done, by this time the river would most certainly have been almost entirely impassable, unless it would be when the river was at flood-tide mark."

Money statement.

July 1, 1896, balance unexpended	$1,015.76
June 30, 1897, amount expended during fiscal year	1,001.12
July 1, 1897, balance unexpended	14.64
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

II. *The North or Middle Fork of Forked Deer River, Tennessee, from Dyersburg to the Obion River, and from thence to the Mississippi River.*—The stream from Dyersburg, Tenn., to the Mississippi River, about 33 miles, is locally known as the North Fork from Dyersburg, Tenn., to its junction with the South Fork, 8½ miles; thence to the Obion River as the Forked Deer River, main stream, 21 miles; thence to the Mississippi River as the Obion River, 3½ miles, and has been heretofore so provided for under sundry appropriations.

A survey was made of this stream from Dyersburg to the Mississippi River in 1894, and report submitted that the stream can not be made navigable "all the year by means of open-channel work," consequently no estimate nor project was made for such work. The general estimate of $400,000 was given in said report for a slack-water system of navigation. (Report of Chief of Engineers, 1895, pp. 2265–2275.)

A resurvey was made in November, 1897, under the provisions of act of June 3, 1896. It was recommended in the report submitting the same that the improvement of the river between Dyersburg and the mouth be confined to clearing snags, shutting off basins, closing secondary channels, and aiding in the general improvement of navigation. (Report published in House Ex. Doc. No. 282, Fifty-fourth Congress, second session.)

By act of June 3, 1896, $5,000 was appropriated for improving the stream from Dyersburg, Tenn., to the Mississippi River under the general name of the North or Middle Fork of the Forked Deer River, for removing bars and shoals, deepening the channel, and improving the navigation of said river; that is, channel work generally.

The project for its expenditure provides for continuing the improvement of the North Fork and the Forked Deer River—main stream—by removing snags, cypress knees, embedded logs, drift, leaning trees, and other surface obstructions, including bars at the mouth of Forked Deer River, and bars and shoals at other points in the channel, from Dyersburg, Tenn., to the Mississippi River, about 33 miles, so as to deepen the channel and make it navigable for small craft at a 3-foot stage or higher. This project was approved July 24, 1896, based upon the provisions of act of June 3, 1896. (Report Chief of Engineers, 1896, p. 1904.)

No expenditures were made on this work in fiscal year ending June 30, 1896.

In the present fiscal year $1,052.94 has been expended in clearing the channel, as provided by act of June 3, 1896. The disbursements are classed as follows:

Pay rolls	$889.82	Explosives	$17.95
Traveling expenses	22.55	Tools, rope, etc	30.50
Transportation	3.25		
Subsistence	76.52	Total	1,052.94
Fuel, lights, etc	12.35		

Operations were begun September 23 and suspended October 11. Work commenced by blasting out the sunken logs and trees that formed a bar at the mouth of the Forked Deer River, thence moving up the main stream to mouth of South Fork, about 21 miles, clearing the channel of snags, leaning trees, and surface obstructions generally. The lower reaches of the river were greatly obstructed by a continuous mass of drift, logs, stumps, etc., requiring explosives to remove them.

Work done.—Two hundred and seventy snags and 26 stumps and logs blasted and removed; 745 snags topped; 46 leaning trees cut down, and 59 logs lying along the banks cut up to prevent their being carried into the channel at high water.

The commerce to be benefited consists principally of rafting logs and moving lumber to and from sawmills. Some live stock and general merchandise also reach a market by way of the river.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	1,052.94
July 1, 1897, balance unexpended	3,947.06

Appropriations for improving Forked Deer River, Tennessee, and its navigable branches.

By act of—

August 2, 1882, for South Fork	$3,000
July 5, 1884, for South Fork	2,000
August 5, 1886, for South Fork	5,000
August 11, 1888, for South Fork	2,500
August 11, 1888, for North Fork	4,500
August 11, 1888, for main river	2,500
September 19, 1890, for North Fork and main river	2,500
July 13, 1892, for Forked Deer River (completing improvement)	3,000
Total, to complete project	25,000
June 3, 1896, for Forked Deer River (for maintenance)	1,000
June 3, 1896, for North or Middle Fork, from Dyersburg to Mississippi River	5,000
Total appropriated	31,000

COMMERCIAL STATISTICS.

Forked Deer River, Tennessee, from July 1, 1896, to June 30, 1897.

	Tons.
Cattle	135
Horses and mules	90
Hogs	15
Lumber	80,000
General merchandise	18
Total tonnage	80,258

Estimated value, $59,500.

List of steamboats navigating Forked Deer River, Tennessee.

Name.	Length.	Breadth.	Depth.	Tonnage.
	Feet.	*Feet.*	*Feet.*	
James Laughlin	71.5	15	4.5	28.76
Mary Louisa	51	16	3	39.90

A A 3.

IMPROVEMENT OF CUMBERLAND RIVER, TENNESSEE AND KENTUCKY.

A general description of this stream and of the character of its obstructions generally, with a statement as to efforts made for its improvement from 1830 to 1840, also a detailed statement of the examinations and surveys made by the United States from 1870 to 1880, which formed the basis under which work was carried on until the adoption of the present projects for improvement below and above Nashville, are given in Report of Chief of Engineers, 1896, page 1905 et seq.

The original project provides for channel work as follows:

> To excavate the bars and rock ledges to get an additional depth of water, to contract the waterways in places to get the requisite depth, to remove snags and bowlders from the main channel, and to restrain tributary streams in well-determined channels at their junction with the river.

To increase the depth of water at the shoals at the junction of the Cumberland River with the Ohio River a Board of Engineer Officers recommended the construction of a dike near Smithland, Ky., at an estimated cost of $129,600. (Report of Chief of Engineers, 1888, pp. 1626–1632.) The river and harbor act of September 19, 1890, allotted $30,000 from the appropriation for improving Cumberland River below Nashville, to be expended in improving the mouth of the river as recommended.

The dike as at present constructed, however, secures the object sought after; that is, the passage from the Cumberland River to the Ohio. Bars form in the Ohio River opposite the mouth beyond the end of the dike. These bars shift continually, but there has never been any difficulty in passing from one river to the other since the dike has been completed, while previously the mouth was often closed while each river remained navigable. It seems probable that some time the gap in the dike will have to be protected. With that in view and also to ascertain effect of dike, surveys have been made each year to determine the changes that occur. Up to the present no cutting of the towhead has taken place. It is suggested that if this happens, it would be well to cover the gap with a layer several feet thick of broken stone extended in front of the line of the dike, so that as the bank cuts away the stone will fall in and make a protection. It is also possible that Cumberland Island will have to be further protected.

The present condition is, however, that for an expenditure of $23,716.71 the results sought for under a project estimated at $129,600 have been obtained.

A resurvey of the mouth of the river was made in November, 1896, under the provisions of act of June 3, 1896. (House Doc. No. 283, Fifty-fourth Congress, second session.)

Under the old project and estimates thirteen appropriations were made from 1871 to 1890, aggregating $305,000, the expenditure of which in open channel work has resulted in lengthening the season of navigation, by giving an increased depth at low water, combined with greater security in the passage of various obstructions.

The existing project for improving the river below Nashville consists of (1) the extension of the lock and dam system of the Upper Cumberland to the lower river by the construction of 7 locks and dams, extending from near the mouth of Harpeth River (Lock A) to Big Eddy Shoals (Lock G), the lock chambers to be each 280 feet available length by 52 feet width, the lifts of the locks varying from 8½ to 11½ feet, aggregating about 70 feet; (2) of the improvement of the Kentucky Chute at mouth of river, as recommended by Board of Engineer Officers June 16, 1888 (Report of Chief of Engineers, 1888, p. 1628); (3) of the channel work necessary below Lock G, between Big Eddy Shoals and mouth of river; and (4) snagging and removal of surface obstructions below Nashville. Total estimate of cost of entire improvement, $1,964,500. (Report of Chief of Engineers, 1890, pp. 2151–2161.)

The act of July 13, 1892, appropriated $40,000 for continuing the improvement, including the mouth of the river, and "that $10,000 of this sum, or so much thereof as may be necessary, shall be available for acquiring site and locating lock and dam near the mouth of Harpeth River, Tennessee." This provision forms the initial appropriation for operations under the project or plan as above stated.

Harpeth Shoals are the most formidable obstruction to the navigation of the Lower Cumberland, and to overcome this obstacle the present project has in view that the lock and dam near the mouth of Harpeth River, 41½ miles below Nashville, be pressed to completion as rapidly as possible.

The total amount expended under the present project at the close of the fiscal year ending June 30, 1896, was $43,148.94. These funds were applied to the purchases of sites of lock and abutment of Dam A; the erection of temporary buildings, and of cofferdam, 700 feet long, with riprap protection at its junction with bank; the excavation of lock chamber to the extent advisable before the laying of the lock masonry; the clearing of lock site, right of way, and bank at the lock approaches; removing surface obstructions below Nashville.

During the fiscal year ending June 30, 1897, $19,991.73 was expended, of which $1,302.22 was applied to open channel work.

The disbursements are classified as follows:

Pay rolls	$13,652.23	Temporary buildings	$427.01
Traveling expenses	41.58	Tramway	584.13
Subsistence	1,735.01	Explosives	203.25
Fuel, lights, etc	1,323.68	Office rent and supplies	424.88
Repairs of steamboats, barges, etc	369.04	Miscellaneous	205.79
Tools, machinery, etc	1,025.13	Total	19,991.73

Channel work was begun on September 12, with the same fleet that was used on the Cumberland River above Nashville. The work consisted mainly in thoroughly clearing the channel of surface obstructions from Nashville to mouth of river, 191 miles. At Dover, a channel was cut with scrapers through a gravel bar, and a riprap dam built of logs and stone. Work was suspended October 31.

In August, a survey party was organized to make examination of the river having in view the selection of a suitable location for the sites of lock and abutment of Dam B, the second lock of the series below Nashville. Necessary lines of soundings and test borings were made in river between Lock A and Hollingsworth Landing, about 9½ miles below Lock A, or 51 miles below Nashville. The topography of the banks of the river was also taken at this point, which has been selected, and will be recommended for approval, as the sites for lock and abutment of Dam B; the lock site selected is on the left bank. Property lines were also located at both sites, and permanent hubs placed on base line and at land corners. A bench mark was established on left bank below Coxs Branch, and three on left bank at lock site. The sites having been selected, the survey party returned to Lock A. The map of proposed sites of Lock and Abutment B is not yet completed, but will be submitted at an early day.

At Lock A: Built a crib pier above cofferdam and erected derrick on same for unloading supplies; quarried 50 yards stone for filling pier crib; placed paving on bank at head of cofferdam; cleared boat channel, 5 stumps, 2 snags, and 1 log taken out; set up traveler and derricks for handling stone; built tramway and incline for transporting stone. In March, opening quarry and quarrying stone for lock walls, which work was in progress at the close of the fiscal year; quarry stripped, 5,526 cubic yards; stone quarried for masonry, 4,571 cubic yards; of this stone 956½ cubic yards has been delivered at lock, etc. Painted U. S. S. *Weitzel* and placed new turntable in position on U. S. dredge *Cumberland.* The work done was largely of a preparatory character.

The work done during the fiscal year has not actually increased the availability or adaptability of the improvement for the purposes of navigation and commerce, and it cannot be so increased until Lock A is completed and operated, but the channel has been cleared of snags, etc., that form from year to year.

The cost of maintenance of the river below Nashville in its present condition is estimated at about $5,000 per annum. As each lock is completed the cost will be increased from $4,000 to $5,000 per lock. When the whole system of six locks is completed, including the channel work to be done each year below the locks, and to maintain connection with the Ohio River, the probable cost of maintenance will be about $50,000 per annum.

The commerce of the Lower Cumberland River during the fiscal year, so far as could be ascertained, consisted principally of grain, tobacco, sand, lumber, bricks, salt, staves, and general merchandise, aggregating 32,703 tons, having an estimated value of $1,512,637.50.

The estimate of cost of improving Cumberland River below Nashville, in accordance with existing project	$1,964,500.00
Amount appropriated under existing project	150,000.00
Amount expended under existing project, including outstanding indebtedness	66,420.77

Money statement.

July 1, 1896, balance unexpended	$106,851.06
June 30, 1897, amount expended during fiscal year	19,991.73
July 1, 1897, balance unexpended	86,859.33
July 1, 1897, outstanding liabilities	3,280.10
July 1, 1897, balance available	83,579.23
Amount (estimated) required for completion of existing project	1,814,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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2. ABOVE NASHVILLE (497 MILES), FROM NASHVILLE TO CUMBERLAND FORD.

A general description of the Upper Cumberland, from Nashville to Cumberland Ford (Pineville), and of the character of its obstructions, the seven appropriations made from 1876 to 1884 for its improvement in specified sections, aggregating the sum of $346,000, are given in Report of Chief of Engineers, 1896, pages 1907–1908.

The disbursements incident to the works above Nashville under the above-named appropriations were from March, 1877, to December, 1887, and the work done consisted of clearing the channel of snags and other surface obstructions, in deepening the channel by excavation over the worst shoals, and the construction of wing dams, and has resulted in obtaining an increased depth at several of the principal obstructions, and thus securing each year a longer and safer period of navigation.

FROM NASHVILLE TO THE HEAD OF SMITH SHOALS, MOUTH OF ROCKCASTLE RIVER, 357 MILES.

The instrumental surveys of 1882 and 1883, with accompanying estimates (Report of Chief of Engineers, 1884, p. 1663 et seq.), furnish the basis of the present project for the radical improvement of the Cumberland River above Nashville.

The project originally provided for the construction of 23 locks and dams between Nashville, Tenn., and Burnside, Ky., and of 7 locks and 2 dams at Smith Shoals, using the river itself as a canal, 1 dam at Mill Shoals and the other at or near Shadowen Shoals, at an estimated cost of $4,077,922. The project stated that the 23 locks between Nashville, Tenn., and Burnside, Ky., "should be about 60 feet wide and 250 feet between miter sills, though perhaps smaller dimensions would answer the purpose" (Report Chief of Engineers, 1884, p. 1664), and that the dimensions of the 7 locks at Smith Shoals were to be "55 by 140 feet in the chamber." (Report Chief of Engineers, 1882, p. 1864.)

This project was modified by enlarging the locks to 280 feet long by 52 feet wide, and having from 10 to 12 feet lift, and by increasing the channel depth to 6½ feet, thus providing for a minimum navigation of 6 feet instead of 4 feet, and further by reducing the number of locks in the Smith Shoals section to 6. (Reports of Chief of Engineers, 1888, p. 1623; 1891, p. 2270; E. D. 6727, 1890; E. D. 12000, 1895.)

The present project, therefore, provides for the radical improvement of the river from Nashville to the head of Smith Shoals, mouth of Rockcastle River, Kentucky, 357 miles, by a complete system of lockage, consisting of 30 locks and dams, if this number be necessary, 23 below Burnside, Ky., and 6 above that point (the Smith Shoals system) with a view to secure a minimum channel depth of 6 feet, locks to be 280 feet long, 52 feet wide, and from 10 to 12 feet lift, at an estimated cost of $8,500,000. (Report of Chief of Engineers, 1896, p. 1916.)

The act of June 3, 1896, provides for the completion of the whole or any part of locks numbered 5, 6, and 7 under the continuing contract system, or otherwise than by contract, not to exceed in the aggregate $600,000, subject to the limitations as to payments enacted in section 5 of said act. The sundry civil act of June 4, 1897, appropriates the sum of $350,000 to meet payments incurred within the limits authorized by law on account of Locks Nos. 5, 6, and 7.

The act of June 3, 1896, appropriates $20,000 for purchasing sites for Locks and Dams Nos. 21 and 22, in Kentucky, and in laying masonry for the same. In the interests of the improvement generally, it is preferable that the masonry of Lock No. 21 be first pressed to completion; therefore the amount available, after paying for the sites required for both locks and abutments of dams, can be best applied in clearing sites, building cofferdam, and preparing foundation for the walls of Lock No. 21, and in payment of the contingent expenses pertaining to the work.

Seven appropriations have been made for this work under the present project, aggregating the sum of $1,345,000.

The amount expended to the close of the fiscal year ending June 30, 1896, was $853,326.74, of which sum, $18,506.76, was expended on account of the Smith Shoals section. The application of this expenditure is set forth in Report of Chief of Engineers, 1896, pages 1912–1915.

The total amount expended during the fiscal year ending June 30, 1897, was $78,692.41, of which $859.68 was expended on account of

Smith Shoals section. These disbursements have been classed as follows:

Lock No. 1	$70.50	Lock No. 22	$295.80
Lock No. 2	47,454.42	Steamer *Weitzel*	1,843.40
Lock No. 3	304.75	Steamer *Susette*	1,126.10
Lock No. 4	771.13	Repairs; barges, etc	122.25
Lock No. 5	17,936.88	Office and general expenses	4,511.63
Lock No. 6	92.92	Smith Shoals	859.68
Lock No. 7	1,542.17	Channel work	1,523.53
Lock No. 8	120.00		
Lock No. 21	117.25	Total	78,692.41

Lock 1 (*2.5 miles below Nashville*).—Masonry of lock and abutment of dam being completed, no work was done during the fiscal year other than watching and taking care of lock keepers' house and engineer property.

Lock 2 (*9 miles above Nashville*).—Stone for lock walls received under contract, 1,908.14 cubic yards; masonry of lock completed October 26, containing 12,815.5 cubic yards, of which 6,922 cubic yards was laid in present fiscal year; 12,758 cubic yards of earth excavated and placed behind land wall; quarry stripped, 1,010 cubic yards; stone quarried and used riprapping and sloping banks, 1,636.4 cubic yards; bank riprapped, 2,092 square yards; erected stone crusher; crushed 1,387.4 cubic yards stone for riprap; mud excavated from lock pit, 1,223 cubic yards; excavated for foundation for retaining crib work, 1,235 cubic yards; sunk crib work to bed rock, 130 feet from lower end of land wall; filled crib with stone, to prevent bank slipping when lower approach is dredged; received 1,175 cubic yards sand and 316 cubic yards of gravel and used same in concrete for filling interstices in masonry. The contract of Petitdidier & Allen for furnishing stone for masonry of Lock No. 2 was completed under its terms, October 1, 1896. Total payments made, $60,783.81. Stone delivered during present fiscal year, 1,908.14 cubic yards; cost, $8,723.62. The contract prices per cubic yard delivered on barges were as follows: Hollow quoins, $21; sills, $15.50; special stones and coping, $13.50; pointed face, $10; squared-faced rubble, $4.50; backing, $3.

Lock 3 (*26 miles above Nashville*).—Active operations suspended August 15, 1895. Engineer property and works in care of watchman.

Lock 4 (*44 3-4 miles above Nashville*).—Loaded and moved machinery, etc., for use at Lock 5; engineer property and works in care of watchman.

Lock 5 (*72 miles above Nashville*).—Operations were carried on from July to February, and again resumed in June. The work consisted principally of laying concrete floor in lock chamber, in accordance with the plan of Board of Engineer Officers, August 26, 1896, approved September 2, 1896. (Report of Chief of Engineers, 1896, pp. 1916–1917.) Miscellaneous work: Sand, 519 cubic yards, and gravel, 1,052.8 cubic yards for concrete, received; stone quarried, 1,717 cubic yards; stone boated, 1,309 cubic yards; concrete laid in foundation, 1,495.3 cubic yards; 350 cubic yards of mud taken from lock pit; 194 cubic yards of rock removed from drain ditch and pump wells in pit; surplus stone received from Lock No. 2, 2,546.72 cubic yards; grading and building incline for moving stone; fencing United States lands; cleaning up machinery; repairing barges, etc. Advertisement was made for bids to be opened March 10, 1897, for supplying stone for masonry of this lock. Only one bid was received—that of G. W. Walker, of Lithonia, Ga., aggregating $238,958.14. This bid was rejected as excessive. Authority was then granted to procure the stone for Lock No. 5 by purchase under existing law and regulations.

Lock 6 (89.6 miles above Nashville).—Bids were opened April 12, 1897, for construction of lock and abutment of dam. The lowest bidder was the McArthur Brothers Company, of Chicago, Ill., to whom the work was awarded, and contract entered into May 4, 1897, approved June 22, 1897, the total consideration of the contract being $164,871.25. The approved project for the expenditure of the $350,000 appropriated by sundry civil act of June 4, 1897, provides that $130,000 thereof shall be applied to payment under said contract.

Lock 7 (106.6 miles above Nashville).—The title to lock site and right of way has been vested in the United States by decree of the district court of the United States for the middle district of Tennessee, and value assessed—$1,000—paid into said court. That part of the abutment site on the main land has been purchased by the United States, but a small piece on Chambers Island has yet to be obtained, and condemnation proceedings are pending to acquire the same. Bids were opened April 12, 1897, for construction of lock and abutment of dam. McArthur Brothers Company, of Chicago, Ill., was the lowest bidder, and contract was entered into with said firm May 4, 1897, approved June 22, 1897, the total consideration of said contract being $181,689.50. The sum of $130,000 is to be applied to payments under said contract for the same reasons given under Lock No. 6.

Lock 21 (296¼ miles above Nashville and 28¾ miles below Burnside, Ky).—Lands condemned for sites of lock and abutment of dam; transcript of proceedings now awaiting action of the Department of Justice.

Lock 22 (320¼ miles above Nashville and 4¾ miles below Burnside, Ky).—Site for abutment has been purchased at a cost of $250, and conveyed to the United States; lands for lock site condemned and awaiting action of the Department of Justice.

By act of June 3, 1896, the sum of $20,000 was appropriated specifically for purchasing sites, and laying masonry of Locks and Dams Nos. 21 and 22. In view of the small amount of funds available and in the interest of the works generally it is preferable, after paying for the sites for both locks, that the masonry of Lock No. 21 be first pressed to completion.

The U. S. steamers *Weitzel* and *Susette* were employed during the fiscal year towing stone from quarry near Nashville to Lock 2, and moving heavy supplies, coal, machinery, lumber, etc., needed for the several works of lock construction.

Channel work was in progress at Cloyds Landing at the beginning of the fiscal year, and was carried on downstream, reaching Nashville September 10. There were removed 663 snags and 1,061 leaning trees from the reach of river worked over—distance about 232 miles. The method used for snagging was that which experience has proven most satisfactory and economical in the Cumberland River. The distance to be gone over is, including above and below Nashville, about 500 miles, and the time between stages of the river too high to work and very low stages is short, so that boats drawing very little water must be used so as to work during low stages. The outfit consisted of a small steamer, the *John Phœnix*, and a strongly built barge, having at one end an A frame, with steam hoisting arrangements, and on the other end the quarters for crew. The head of the barge, on which is the A frame, is built without rake. A short rake extending a few inches above the water would, however, facilitate towing.

A derrick handles material, especially that from the side, more readily than an A frame, but the latter was preferred on account of strength. Dynamite was used for the larger snags, and all obstructions met with were successfully removed.

Smith Shoals, Kentucky.—The improvement of these shoals by locks and dams forms a part of the existing project for the canalization of the river above Nashville; the Smith Shoals system consisting of seven locks and dams between Burnside, Ky., and mouth of Rock Castle River. (Report Chief of Engineers, 1891, p. 2270.) It has been ascertained that the seven locks will not be necessary, owing to an increase of lift in the other locks, which is rendered advisable by reason of the small river discharge at low water not permitting of any material loss during the season of navigation; also, simplicity of operation and maintenance at the rather inaccessible locations necessarily selected for the lock sites. The project has therefore been modified, reducing the number of locks to six; modification approved August 12, 1895.

Amount allotted "at Smith Shoals," act of September 19, 1890..	$50,000.00	
Less amount made available for expenditure under the approved project for the general improvement of Cumberland River above Nashville, Tenn., by authority of Secretary of War, September 1, 1886	30,000,00	
		$20,000.00
Amount allotted "above Burnside," act of July 13, 1892		5,000.00
Amount allotted "above Burnside," act of August 17, 1894		5,000.00
Total allotted		30,000.00
Amount expended to June 30, 1896	$18,506.76	
Amount expended during fiscal year ending June 30, 1897	859.68	
		19,366.44
Amount available July 1, 1897		10,633.56

The allotments by act of July 13, 1892, and August 17, 1894, provided that $5,000 of each of said general appropriations may be used in the improvement of the river above the town of Burnside. It was recommended and approved that these sums be applied to the Smith Shoals system of lockage, as projected "above Burnside."

During the present fiscal year, abstracts of title have been obtained covering the lands required by the United States for sites for locks and abutments of dams Nos. 1 to 6, and correspondence having in view the acquiring of said lands either by voluntary purchase or condemnation, as authorized, is pending, and action will be taken in the matter during the next fiscal year. The disbursements made, $859.68, were on account of authorized and miscellaneous contingent expenses.

The field and office work pertaining to the surveys of the sites for the locks and dams forming part of the projects for canalization of the Cumberland River from the mouth of Harpeth River on the Cumberland River, below Nashville, to the head of Smith Shoals, mouth of Rock Castle River, including the work of lock construction in progress, has been and now is under the efficient immediate management of Mr. J. S. Walker, principal assistant engineer.

The amount hereinbelow estimated for continuing the work above Nashville under the present project—$1,000,000—can be profitably expended in building abutments at Dams Nos. 2, 3, 4, and 5, constructing permanent dams, placing lock gates and maneuvering appliances, etc., at Locks Nos. 1 to 7, inclusive, excavating approaches to said locks where necessary, and reducing by dredging submerged bars in the pools so as to secure the required minimum depth of 6½ feet navigation, having in view the opening up to commerce by canalization of the river to West Point, about 125 miles above Nashville, or about 9 miles above mouth of Caney Fork River; also in construction of Locks Nos. 21 and 22, in Kentucky, immediately below Burnside.

So far as reports have been received the commerce of the Upper Cumberland River below Burnside during the fiscal year ending June 30, 1897, aggregated 54,994 tons, at an estimated value of $3,067,675, and above Burnside, passing Smith Shoals, 27,681 tons, the estimate value of which was not reported.

Estimate for improving Cumberland River from Nashville to head of Smith Shoals, mouth of Rock Castle River, Ky., under project for canalization	$8,500,000.00
Amount appropriated	1,345,000.00
Amount expended to June 30, 1897	932,019.15
Outstanding liabilities to June 30, 1897	2,682.93
Amount covered by uncompleted contracts to June 30, 1897	260,000.00

Money statement.

July 1, 1896, balance unexpended		$141,673.26
Amount appropriated by sundry civil act approved June 4, 1897		350,000.00
		491,673.26
June 30, 1897, amount expended during fiscal year		78,692.41
July 1, 1897, balance unexpended		412,980.85
July 1, 1897, outstanding liabilities	$2,682.93	
July 1, 1897, amount covered by uncompleted contracts	260,000.00	
		262,682.93
July 1, 1897, balance available		150,297.92

Amount (estimated) required for completion of existing project	7,155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Improving Cumberland River, Tennessee and Kentucky, general river, 1832 to 1838.

Act of—	
July 17, 1832	$30,000
June 28, 1834	30,000
July 7, 1836	20,000
March 3, 1837	55,000
July 7, 1838	20,000
Total	155,000

Improving Cumberland River below Nashville, Tenn.

[Under old projects for open-channel work from 1871 to 1890.]

Act of—		Act of—	
March 3, 1871	$30,000	August 5, 1882	$15,000
June 10, 1872	20,000	July 5, 1884	7,500
March 3, 1873	25,000	August 5, 1886	12,500
March 3, 1875	25,000	August 11, 1888	10,000
June 18, 1878	45,000	September 19, 1890	40,000
March 3, 1879	40,000		
June 14, 1880	20,000	Total	305,000
March 3, 1881	15,000		

[Under new project for locks and dams, from 1892 to 1897.]

Act of—	
July 13, 1892	$40,000
August 17, 1894	30,000
June 3, 1896	80,000
Total	150,000

Improving Cumberland River above Nashville, Tenn., under original projects for open-channel work, from 1876 to 1884.

Geographical division.	Act of— Aug. 14, 1876.	June 18, 1878.	Mar. 3, 1879.	June 14, 1880.
1. Nashville to Kentucky line	$15,000	$20,000	$18,000	$15,000
2. Kentucky line to Smith Shoals	10,000	8,000	6,000	10,000
3. Smith Shoals	25,000	30,000	15,000	20,000
4. Smith Shoals to Falls of Cumberland	2,000	2,000		
Total	52,000	60,000	39,000	45,000

Geographical division.	Act of— Mar. 3, 1881.	Aug. 2, 1882.	July 5, 1884.	Total.
1. Nashville to Kentucky line	$15,000			$83,000
2. Kentucky line to Smith Shoals	15,000			49,000
3. Smith Shoals	10,000	$15,000		115,000
4. Smith Shoals to Falls of Cumberland				4,000
5. Above mouth of Jellico, Ky	10,000	5,000		15,000
6. Nashville to Smith Shoals		30,000		30,000
7. Nashville to head of Smith Shoals			$50,000	50,000
Total	50,000	50,000	50,000	346,000

Improving Cumberland River above Nashville, Tenn., under the present project for a system of locks and dams, from Nashville, Tenn., to head of Smith Shoals, mouth of Rockcastle River, Kentucky.

Act of—	
August 5, 1886	$75,000
August 11, 1888	200,000
September 19, 1890	250,000
July 13, 1892	250,000
August 17, 1894	200,000
June 3, 1896	$20,000
June 4, 1897 (sundry civil act)	350,000
Total	1,345,000

Abstract of proposal for furnishing stone for lock and abutment of Dam No. 5, Cumberland River, delivered on United States lands, opened March 10, 1897, by Capt. John Biddle, Corps of Engineers.

QUANTITIES AND PRICES.

Name and address of bidder.	Lock. Sills, 108 cubic yards. Per cubic yard.	Cost.	Hollow quoins, 102 cubic yards. Per cubic yard.	Cost.	Special stones, 175 cubic yards. Per cubic yard.	Cost.	Coping, 386 cubic yards. Per cubic yard.	Cost.
G. W. Walker, Lithonia, Ga.[a]	$36.06	$3,894.48	$52.06	$5,310.12	$53.05	$9,177.65	$41.00	$15,826.00

Name and address of bidder.	Lock. Pointed face, 2,077 cubic yards. Per cubic yard.	Cost.	Squared-faced rubble, 1,100 cubic yards. Per cubic yard.	Cost.	Backing, 2,800 cubic yards. Per cubic yard.	Cost.
G. W. Walker, Lithonia, Ga.[a]	$36.57	$75,955.89	$28.00	$30,800.00	$24.00	$67,200.00

Name and address of bidder.	Abutment. Squared-faced rubble, 344 cubic yards. Per cubic yard.	Cost.	Backing, 950 cubic yards. Per cubic yard.	Cost.	Grand total cost.
G. W. Walker, Lithonia, Ga.[a]	$26.00	$8,944.00	$23.00	$21,850.00	$238,958.14

[a] Rejected.

Abstract of proposals for construction of lock and abutment of Dam No. 6, Cumberland River, opened April 12, 1897, by Capt. John Biddle, Corps of Engineers.

QUANTITIES AND PRICES.

No.	Name and address of bidder.	Earth excavation, 9,380 cubic yards.		Rock excavation, 4,290 cubic yards.		Approach excavation, rock, 4,130 cubic yards.		Approach excavation, earth, 300 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa.	$0.75	$7,035.00	$3.00	$12,870.00	$3.00	$12,390.00	$0.75	$225.00
2	Heldmaier & New, Chicago, Ill.	.75	7,035.00	2.00	8,580.00	1.10	4,543.00	.40	120.00
3	Christie & Lowe, Chicago, Ill.	.40	3,752.00	2.00	8,580.00	1.20	4,956.00	.80	240.00
4	McArthur Bros. Co., Chicago, Ill.	.50	4,690.00	2.50	10,725.00	.80	3,304.00	.25	75.00

No.	Name and address of bidder.	Embankment, 7,960 cubic yards.		Stone filling, 2,400 cubic yards.		Puddling, 800 cubic yards.		Concrete, 300 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa.	$0.60	$4,776.00	$2.00	$4,800.00	$2.00	$1,600.00	$7.00	$2,100.00
2	Heldmaier & New, Chicago, Ill.	.35	2,786.00	1.00	2,400.00	.75	600.00	4.00	4,200.00
3	Christie & Lowe, Chicago, Ill.	.30	2,388.00	.50	1,200.00	1.50	1,200.00	5.00	1,500.00
4	McArthur Bros. Co., Chicago, Ill.	.25	1,990.00	.25	600.00	.75	600.00	8.00	2,400.00

No.	Name and address of bidder.	Paving, 750 cubic yards.		Riprap, hand placed, 400 cubic yards.		Sills, 98 cubic yards.		Hollow quoins, 105 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa.	$5.00	$3,750.00	$3.00	$1,200.00	$28.00	$2,744.00	$30.00	$3,150.00
2	Heldmaier & New, Chicago, Ill.	4.50	3,375.00	2.50	1,000.00	21.25	2,082.50	25.45	2,672.25
3	Christie & Lowe, Chicago, Ill.	4.00	3,000.00	3.50	1,400.00	20.00	1,960.00	35.00	3,675.00
4	McArthur Bros. Co., Chicago, Ill.	5.00	3,750.00	1.75	700.00	18.00	1,764.00	22.00	2,310.00

No.	Name and address of bidder.	Special stones, 390 cubic yards.		Coping, 386 cubic yards.		Pointed face, 2,276 cubic yards.		Squared-faced rubble, 1,854 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa.	$28.00	$10,920.00	$24.00	$9,264.00	$22.00	$50,072.00	$13.00	$24,102.00
2	Heldmaier & New, Chicago, Ill.	21.50	8,385.00	25.45	9,823.70	18.30	41,650.80	12.40	22,989.60
3	Christie & Lowe, Chicago, Ill.	20.00	7,800.00	20.00	7,720.00	16.50	37,554.00	8.50	15,759.00
4	McArthur Bros. Co., Chicago, Ill.	16.00	6,249.00	17.00	6,562.00	11.50	26,174.00	8.00	14,832.00

Abstract of proposals for construction of lock and abutment of Dam No. 6, etc.—**Cont'd.**

QUANTITIES AND PRICES—Continued.

No.	Name and address of bidder.	Backing, 7,990 cubic yards.		Brick masonry, 20 cubic yards.		Cofferdam filling, 9,000 cubic yards.		Cofferdam lumber in place, 360,000 feet B. M.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per 1,000 feet B. M.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$12.00	$95,880.00	$17.00	$340.00	$1.50	$13,500.00	$30.00	$10,800.00
2	Heldmaier & New, Chicago, Ill	10.90	87,091.00	17.00	340.00	1.50	13,500.00	32.00	11,520.00
3	Christie & Lowe, Chicago, Ill	6.00	47,940.00	15.00	300.00	1.50	13,500.00	60.00	21,600.00
4	McArthur Bros. Co., Chicago, Ill	6.25	49,937.50	10.00	200.00	.70	6,300.00	40.00	14,400.00

No.	Name and address of bidder.	Timber in permanent construction, 200,000 feet B. M.		Bolt holes in masonry, 800 linear feet.		Wire fence in place, 3,165 linear feet.		Grand total cost.
		Per 1,000 feet B. M.	Cost.	Per linear foot.	Cost.	Per linear foot.	Cost.	
1	J. V. Hoag, jr., Pittsburg, Pa	$65.00	$13,000.00	$0.50	$400.00	$0.50	$1,582.50	$286,500.50
2	Heldmaier & New, Chicago, Ill	28.00	5,600.00	2.00	1,600.00	.10	316.50	242,210.35
3	Christie & Lowe, Chicago, Ill.	35.00	7,000.00	1.00	800.00	.15	474.75	194,298.75
4	McArthur Bros. Co., Chicago, Ill	35.00	7,000.00	.20	160.00	.05	158.25	164,871.75

Abstract of proposals for construction of lock and abutment of Dam No. 7, Cumberland River, opened April 12, 1897, by Capt. John Biddle, Corps of Engineers.

QUANTITIES AND PRICES.

No.	Name and address of bidder.	Earth excavation, 96 cubic yards.		Rock excavation, 50 cubic yards.		Embankment, 16,100 cubic yards.		Stone filling, 5,000 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$1.00	$9,600.00	$5.00	$250.00	$0.75	$12,075.00	$3.00	$15,000.00
2	Heldmaier & New, Chicago, Ill	.75	7,200.00	2.00	100.00	.35	5,635.00	1.00	5,000.00
3	Christie & Lowe, Chicago, Ill	.40	3,840.00	2.50	125.00	.35	5,635.00	.80	4,000.00
4	McArthur Bros. Co., Chicago, Ill	.50	4,800.00	3.00	150.00	.25	4,025.00	.60	3,000.00

No.	Name and address of bidder.	Puddling, 800 cubic yards.		Concrete, 500 cubic yards.		Paving, 2,000 cubic yards.		Riprap, hand placed, 2,500 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$2.00	$1,600.00	$8.00	$2,400.00	$5.00	$10,000.00	$3.00	$7,500.00
2	Heldmaier & New, Chicago, Ill	.75	600.00	14.50	4,350.00	4.50	9,000.00	2.50	6,250.00
3	Christie & Lowe, Chicago, Ill	1.50	1,200.00	5.00	1,500.00	3.00	6,000.00	2.60	6,250.00
4	McArthur Bros. Co., Chicago, Ill	.75	600.00	8.00	2,400.00	4.50	9,000.00	2.10	5,250.00

Abstract of proposals for construction of lock and abutment of Dam No. 7, etc.—**Cont'd.**

QUANTITIES AND PRICES—Continued.

No.	Name and address of bidder.	Sills, 98 cubic yards.		Hollow quoins, 105 cubic yards.		Special stones, 502 cubic yards.		Coping, 403 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$29.00	$2,842.00	$31.00	$3,255.00	$29.00	$14,558.00	$25.00	$10,075.00
2	Heldmaier & New, Chicago, Ill	21.25	2,082.50	25.35	2,661.75	21.15	10,617.30	25.35	10,216.05
3	Christie & Lowe, Chicago, Ill	20.00	1,960.00	35.00	3,675.00	20.00	10,040.00	20.00	8,060.00
4	McArthur Bros. Co., Chicago, Ill	18.00	1,764.00	22.00	2,310.00	16.00	8,032.00	17.00	6,851.00

No.	Name and address of bidder.	Pointed face, 2,450 cubic yards.		Squared-faced rubble, 1,597 cubic yards.		Backing, 9,238 cubic yards.		Brick masonry, 20 cubic yards.	
		Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.	Per cubic yard.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$23.00	$56,350.00	$14.00	$22,358.00	$13.00	$120,094.00	$17.00	$340.00
2	Heldmaier & New, Chicago, Ill	18.20	44,590.00	12.35	19,722.95	10.75	99,308.50	18.00	360.00
3	Christie & Lowe, Chicago, Ill	16.50	40,425.00	8.50	13,374.50	6.00	55,428.00	15.00	300.00
4	McArthur Bros. Co., Chicago, Ill	11.50	28,175.00	7.50	11,977.50	6.25	57,737.50	10.00	200.00

No.	Name and address of bidder.	Cofferdam filling, 11,400 cubic yards.		Cofferdam lumber in place, 450,000 feet B. M.		Timber in permanent construction, 260,000 feet B. M.	
		Per cubic yard.	Cost.	Per 1,000 feet B. M.	Cost.	Per 1,000 feet B. M.	Cost.
1	J. V. Hoag, jr., Pittsburg, Pa	$1.50	$17,100.00	$30.00	$13,500.00	$65.00	$16,900.00
2	Heldmaier & New, Chicago, Ill	1.50	17,100.00	33.00	14,850.00	29.00	7,540.00
3	Christie & Lowe, Chicago, Ill	1.40	15,960.00	55.00	24,750.00	35.00	9,100.00
4	McArthur Bros. Co., Chicago, Ill	.70	7,980.00	40.00	18,000.00	35.00	9,100.00

No.	Name and address of bidder.	Bolt holes in masonry, 900 linear feet.		Wire fence in place, 3,150 linear feet.		Grand total cost.
		Per linear foot.	Cost.	Per linear foot.	Cost.	
1	J. V. Hoag, jr., Pittsburg, Pa	$0.50	$450.00	$0.50	$1,575.00	$337,822.00
2	Heldmaier & New, Chicago, Ill.	2.00	1,800.00	.10	315.00	269,299.05
3	Christie & Lowe, Chicago, Ill.	1.00	900.00	.15	472.50	213,195.00
4	McArthur Bros. Co., Chicago, Ill	.20	180.00	.05	157.50	181,689.50

List of contracts in force during the fiscal year ending June 30, 1897, for improving Cumberland River above Nashville, Tenn.

No.	Name and address of contractors.	Purpose.	Date entered into.	Date of approval.	Date of beginning work.	Date of expiration.
1	Petitdidier & Allen, Nashville, Tenn. *a*	Furnishing stone for building Lock No. 2.	Oct. 13, 1894	Nov. 4, 1894	Between Mar. 1, and 10, 1895.	Oct. 1, 1896
2	McArthur Bros. Co., Chicago, Ill. *b*	Construction of lock and abutment of Dam No. 6.	May 4, 1897	June 22, 1897	June 8, 1897	May 1, 1899
3	....do *b*..............	Construction of lock and abutment of Dam No. 7.	....do.......	....do.......	July 12, 1897	Do.

a Contract completed October 1, 1896.

b In force.

COMMERCIAL STATISTICS.

Cumberland River below Nashville, Tenn., from July 1, 1896, to June 30, 1897.

Articles.	Tons.	Articles.	Tons.
Brick	90	Lumber	700
Cattle	360	Salt	450
Coal	440	Sand	7,912
Flour	340	Shingles	6
Grain	6,055	Staves	2,500
Hay	400	Tobacco	3,500
Horses and mules	300	General merchandise	9,000
Hogs	260		
Iron	390	Total tonnage	32,703

Estimated value, $1,512,637.50.
Number of passengers carried, 4,340.

Cumberland River above Nashville, Tenn., from July 1, 1896, to June 30, 1897.

Articles.	Tons.	Articles.	Tons.
Brick	381	Lumber	6,000
Cattle	1,030	Salt	2,583
Coal	1,460	Shingles	45
Cross ties	75	Staves	250
Flour	790	Sand	12,525
Grain	4,100	Tobacco	2,025
Hay	175	General merchandise	20,200
Horses and mules	160		
Hogs	2,595	Total tonnage	54,994
Iron	600		

Estimated value, $3,067,675.
Total number of passengers carried, 9,072.

Cumberland River above Nashville, Tenn., above Burnside, Smith Shoals, from July 1, 1896, to June 30, 1897.

Articles.	Tons.
Cross-ties	15,000
Logs	12,600
Staves	81
Total tonnage	27,681

Estimated value not reported.

List of steamboats (stern-wheel) plying on the Cumberland River, Tennessee and Kentucky, June 30, 1897.

Name.	Register dimensions.			Net tonnage.
	Length.	Breadth.	Depth.	
	Feet.	*Feet.*	*Feet.*	
A. L. Goldberg	129	20	3	58.20
Eleanor	63	16	3.4	23.87
Huntsville	125	24	4	89.99
Hattie McDaniel	90.5	18	2.5	90.63
H. W. Buttorff	160	30	4.1	160.16
Ida	66	17	3.5	15.82
Jas. N. White	147	27	3	77.19
John Orm No. 3	95	17	3.5	95.33
John T. Carson	85	18.8	3	47.60
Kenton	105.2	33	5.2	153.06
Lula E. Warren	122	22.5	3.8	78.78
P. D. Staggs	161	28.6	4.4	261.28
R. Dunbar	160	29.4	6.4	158.80
Sycamore	103.6	20.8	3	69
W. K. Phillips	165	30	4	196.06
W. T. Harwell	72.9	15.9	3.8	24.48
W. J. Bryan	100	18	4	46.21
J. B. Horton (side-wheel)	65	14	4	32.80

A A 4.

SURVEY OF NORTH FORK OF FORKED DEER RIVER, TENNESSEE, FROM DYERSBURG TO THE MAIN STREAM, AND THENCE TO OBION RIVER, WITH A VIEW OF DEEPENING THE CHANNEL AND IMPROVING NAVIGATION FROM DYERSBURG TO THE MISSISSIPPI RIVER.

[Printed in House Doc. No. 282, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 6, 1897.

SIR: The river and harbor act of June 3, 1896, directs the Secretary of War, at his discretion, to cause a survey to be made and the cost of improvement to be estimated at the following locality, viz:

> North Fork of Forked Deer River, Tennessee, below Dyersburg, with a view of removing the snags, cypress knees, and other obstructions, and for dredging out and removing the bars and shoals at Caney Point Shoal, 8 miles below Dyersburg; at Basin No. 1, 12¼ miles below Dyersburg; at Basin No. 2, 13¼ miles below Dyersburg; at McCoys Shoal, 14¾ miles below Dyersburg; at Shoal Cut-off No. 2, 14¼ miles below Dyersburg and below the mouth of Forked Deer River; and for straightening the river one-half mile below Dyersburg; and for removing snags, blasting embedded trees and snags in the river from Key Corner to junction with Obion River, so as to deepen the channel and improve the navigation of said river from Dyersburg to the Mississippi River.

The duty of making the survey thus provided for was assigned to the charge of Capt. John Biddle, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, dated January 26, 1897, upon the subject.

Captain Biddle is of opinion that a gain of a few inches in depth could probably be effected in the upper part of the river by building bank protection to preserve the channel, narrowing the wide places with dams, filling up basins, shutting off one of the branches at cut-offs, and possibly dredging, but that no improvement in the lower river could be made permanent, except at great expense, so long as the water of the Mississippi River is permitted to cover the bottom lands. In other words, he does not consider a permanent low-water navigation practicable, except by means of canalization. He accordingly recommends that the improvement of the river between Dyersburg and the mouth be confined to clearing snags, shutting off basins, closing secondary channels, and aiding in the general improvement of navigation. The sum of $3,000 per year would be required to effect this object.

In transmitting the report to this office the division engineer, Col. J. W. Barlow, Corps of Engineers, concurred in the views and recommendations of the district officer.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., January 26, 1897.

GENERAL: I have the honor to submit the following report of survey of the North Fork of Forked Deer River, Tennessee, below Dyersburg, with a view of removing the snags, cypress knees, and other obstructions, and for dredging out and removing the bars and shoals at Caney Point Shoal, 8 miles below Dyersburg; at Basin No. 1, 12½ miles below Dyersburg; at Basin No. 2, 13½ miles below Dyersburg; at McCoys Shoal, 14¾ miles below Dyersburg; at Shoal Cut-off No. 2, 14¼ miles below Dyersburg and below the mouth of Forked Deer River; and for straightening the river one-half mile below Dyersburg; and for removing snags, blasting embedded trees and snags in the river from Key Corner to junction with Obion River, so as to deepen the channel and improve the navigation of said river from Dyersburg to the Mississippi River, provided for by the river and harbor act of June 3, 1896, and submitted in obedience to letter dated Office Chief of Engineers, September 5, 1896.

This survey was made by Mr. O. L. Petitdidier from October 28 to November 16, 1896. His report is hereto appended. The map* of the river was also drawn by him. This map (five sheets) is transmitted herewith. * * *

The work was done as late in the season as possible, so as to have the water at the lowest probable stage. * * * A description of the river and of the special shoals named is given in Mr. Petitdidier's report. The part of the river examined extends from Dyersburg to the Obion River, about 29 miles.

The distance from Dyersburg, the head of survey, to the junction of the South Fork is 8 miles; thence to Key Corner, where the character of the river changes, is 11¾ miles; thence to the point where the Forked Deer empties into the Obion, 9½ miles, and thence to the Mississippi, 3½ miles.

The depth generally varies from 3 to 12 feet, but with a number of stretches of about 2 feet or less, the river forming an irregular succession of pools and shoals. There is a general relation between curves and depths, the shallows being usually on straight reaches and the deep places on curves, but with many exceptions to the rule. At cut-offs there are usually shallow places due to decreased flow through either channel, and at points where the so-called basins are situated there are also shallow stretches.

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*Not printed.

Above Key Corner the slope is comparatively light, the erosion not great, and the bed fairly stable. Below Key Corner the slope doubles, sand bars are continually forming and shifting, the banks are being eroded, and, besides, the Mississippi at high water covers all this area, bringing in snags, forming bars, and making any improvement uncertain and unsatisfactory.

In the upper part of the river, by building bank protection to preserve the channel, by narrowing the wide places with dams, filling up basins, shutting off one of the branches at cut-offs, and possibly dredging, a gain of a few inches could probably be effected. In the lower part of the river, as long as the Mississippi is allowed to cover the bottom lands, I do not think that any improvement could be made permanent, except at great expense.

In discussing the navigability of this river and the Obion the final object in view has usually been to obtain a low-water navigation. All the work done so far, however, has been directed only toward facilitating a medium and high stage navigation. I do not think low-water navigation practicable except by canalization. The instructions under which this survey has been made state "so as to deepen the channel and improve the navigation."

By far the bulk of the commerce of the river is timber and lumber, and it is found that this can be most advantageously handled either by rafts or by barges, with the tugs drawing 5 to 6 feet of water. A high stage of water is evidently necessary for these tugs. The Mississippi River backs up the Obion and Forked Deer rivers for several months of the year, and causes longer high-water seasons than the size of the stream would otherwise give.

There has been an effort made at times to ship cotton and other produce by the river. While I understand the existence of the river navigation controls rates, and is, therefore, of great benefit, the amounts shipped have not been very great.

The effort at present should then, I believe, be to facilitate the medium and higher stages of river navigation.

Mr. Petitdidier, in discussing the subject, suggests that the river be thoroughly snagged each year, that the basins be shut off by depositing snags across the entrance, and that the cut-offs be allowed to form, assisted by dredging and clearing. I concur with him as to the snagging and the treatment of the basins. As to the cut-offs for lower stages, they are certainly disadvantageous, as they would usually form a more rapid, narrower, and more unstable channel. In high water the relative rapidity and narrowness would probably not be so great, and there would be a gain of distance. Unless the cut-off is already so far advanced as to make it impracticable to stop, I believe as a rule it would be best to prevent its formation.

In case of Cut-off No. 1, it would seem best to allow the cutting to proceed. In case of Cut-off No. 2, or Six Mile Cut-off, it should be left to next season or later to decide.

The funds allotted did not allow of an extended enough survey for me to give a decided opinion on the subject of cut-offs on the Forked Deer or Obion rivers.

In my annual report for 1896 (Report Chief of Engineers, 1896, p. 1902) I recommended $1,000 a year to be spent on the Forked Deer for maintenance. The results of this season's snagging have shown me that this is not sufficient. The snags come in in such numbers each year that the whole navigable part of the river should be gone over yearly, especially the lower part.

For these reasons I would recommend, as suggested by Mr. Petitdidier, for the present, an appropriation of $3,000 per year, to be used on the Forked Deer River from Dyersburg to its mouth, to clear off snags, and to aid in the general improvement of navigation.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. O. L. PETITDIDIER, SURVEYOR.

NASHVILLE, TENN., *December 19, 1896.*

CAPTAIN: I have the honor to present the following report upon the examination and survey of the North or Middle Fork of Forked Deer River from Dyersburg, Tenn., to its junction with the South Fork, 8 miles below, and of the main stream from this point to its junction with the Obion River at Tiger Tail, a distance in all of 29.05 miles.

In obedience to your orders, I left Nashville for Dyersburg on October 28; survey was commenced at once and carried on until its completion, November 16.

According to the instructions received from you, the survey was to consist of an examination of the river from Dyersburg to its mouth, with a view of ascertaining the number of snags, logs, embedded trees, or other obstructions in the channel of the river, or any changes which might have occurred since former survey.

In addition to this a thorough examination and survey was to be made at the following points: Cut-off, one-half mile below Dyersburg; Caney Point Shoals, 7½ miles below Dyersburg; Basin No. 1, 12 miles below Dyersburg; Basin No. 2, 12½ miles below Dyersburg; Cut-off No. 2, or more properly Six Mile Cut-off, 13½ miles below Dyersburg, and McCoys Shoals, 14½ miles below Dyersburg.

The plan adopted in the examination of the river has consisted of taking a continuous line of soundings at intervals of about 65 feet or even closer when necessary along the channel, or as near as possible such a channel as a steamboat would naturally follow.

The river being narrow (from 50 to 200 feet), this line of soundings was for the most part run near the middle of the stream.

Sketches were made at the time, and all visible snags, logs, embedded trees, or other obstructions carefully noted down and located with regard to the nearest sounding. Sloughs, creeks, cut-offs, basins, old channels, sand bars, and all other prominent landmarks were carefully sketched in and results compared with the existing maps of the river.

This continuous line of soundings does not always show the greatest depth of water in the river, but does, in my estimation, show the amount of water which a boat could reasonably expect to find in following an average channel.

These soundings have been located on the maps accompanying this report by using the points common to the sketches and to the existing maps of the stadia survey of 1894, and dividing the distances into an equal number of parts corresponding to the number of soundings taken between those points.

In general, this method has given very good results, the sharp bends, bars, sloughs, and other points used as landmarks are generally so close together that the error of location of soundings is small and can never be carried very far.

The special surveys made at each of the points required by your instructions were made by means of transit and stadia; shore lines and top of banks were carefully located every 50 feet, and even less when required; lines of soundings 50 feet apart were taken across the stream and to such a distance above and below location of special survey as to cover all area where the depth of water was less than 5 feet.

The stage of water was carefully referred to former surveys by running lines of levels to the established bench mark, and such a stage has been indicated on maps. Cross sections, height of banks, and profile were also taken at each location, and all information available in regard to each particular case was secured.

Current directions and discharges were also obtained at each location and referred to low water.

The result of examination of river, outside of special surveys, which will be treated separately, is as follows, viz:

The North Fork of Forked Deer River, from wagon bridge at Dyersburg to its junction with the South Fork, a distance of 7¾ miles, is from 50 to 110 feet wide, its average width being about 70 feet, its smallest depth being 1 foot 3 inches.

In general, the depth is very good, the shoal places being only three in number, and the longest being only one-fourth mile long; the bottom of river is composed of alluvium or mud, with the addition on some of the shoals of fine sand.

The river is crooked and has many bends of short radius, among others one bend of 100 feet radius. The river banks are at high water overflowed by several feet for a considerable width (generally several miles on each side of the river), their height next to the river varying between 10 and 25 feet, averaging 12 to 14 feet.

The banks are generally quite stable, being very frequently covered with large trees, so that the wear is gradual, except on concave side of bends, when erosion takes place, as is shown on the maps.

The slope of river in this portion is very gradual, the fall in 7¾ miles being 3.28 feet. Discharge at extreme low water, 130 cubic feet per second.

Snags are the worst obstructions to navigation. The number of snags and embedded trees or logs which ought to be removed is considerable, there being about 157 snags, etc., noted.

Cut-off one-half mile below Dyersburg and Caney Point Shoals are both contained in this section of river.

This portion of river flows through very rich land, much of which is cultivated and partly cleared. Some 15 farms are scattered on the distance described.

From South Fork to Key Corner, a distance of 11.75 miles, the river has much increased in width and volume, and the same conditions prevail as in the North Fork, differing only in the larger scale.

The main stream, formed by the union of the North and South forks, is now from 80 to 200 feet in width, averaging probably 140 feet, but coming down once to 65 feet; its smallest depth, 1 foot 10 inches, in a shoal about one-half mile long. Although this section contains many stretches of deep water several miles in length, yet there are several shoals with an available depth of only 2 feet. Basin No. 1, Basin No. 2, Six Mile Cut-off, and McCoys Shoals, where special surveys have been made, are all contained in this section.

The bends increase in radius, the two shortest being of 200 feet radius, but are still very abrupt, the river frequently making a turn at less than at right angles.

The banks decrease in average height, averaging only 10 to 12 feet above low water. The material of which they are formed does not seem as compact as before, and erosion takes place on a more serious scale. We also come upon a new feature: We frequently find basins, generally at the beginning or foot of a bend, which it is thought are the cause of shoaling in their proximity. These basins are lined on their periphery with a wide fringe of large cypress trees. They are all very symmetrical in regard to their position on the river, and the cause of their formation is unknown.

The banks are overflowed as before, but to a larger extent. We also find that the banks are frequently paralleled by sloughs 8 to 10 feet deep, through which the river flows at high stages. These sloughs are nearly always closely timbered with cypress trees, which prevent erosion.

We now find evidences of cultivation fast disappearing, and on all this section the boundaries of the river are heavily wooded with fine timber. Four farms on this section.

The slope is still slight; fall from South Fork to Key Corner, 2.81 feet. Discharge at stage of water, 1½ inches above extreme low water—470 cubic feet per second.

Snags are again numerous, 405 being noted. Overhanging trees are also in the way in several places. Frequently they have been deadened and left standing, but I would deprecate this practice, as those trees are not only a menace to all passing craft, but also restrict to a large extent a stream already far too narrow. If overhanging trees are in the way they should be cut down at once and sawed into small, harmless sections.

The much greater surface slopes which prevail between Key Corner and the mouth of the river (9.55 miles) have produced new conditions, and we find, therefore, the river somewhat narrower and much swifter, a large number of sand bars, sand reefs, narrower channel, and a much greater erosion of banks.

Another element of instability and one which can not be overcome at present is the nearness of the Mississippi River, which modifies the Forked Deer River very materially for a distance of 5 miles from its mouth. The Mississippi when on a rise flows up the Forked Deer River at times with a velocity of 5 miles per hour, and deposits enormous quantities of sand, drift, snags, or other débris.

Upon the recession of the Mississippi River the Forked Deer River is unable to cut out promptly all the sand or carry out all the snags which have been deposited, and we have therefore a new imperfect channel with all sorts of obstructions.

At the time of examination it was found that the large sand bar at the mouth of the Obion River had disappeared. This bar was mentioned in Mr. Ben Smith's report on his survey of 1894 as bad. This illustrates the instability of the channel in the lower portions of the river.

For the first 5 miles from Key Corner the river, varying between 100 and 200 feet in width, is much swifter; its smallest depth, 1 foot 3 inches at six different points. The last 4 miles, the stage of water of which was affected by a rise in the Mississippi, showed 2 feet 6 inches as the lowest water.

The bends are still numerous and short, among others one bend of 200 feet radius.

Banks which are low in the first part, from 10 feet to 14 feet in height, rise to heights of 31 feet on approaching the mouth of the river. The banks are sandy and erode rapidly on the concave side of the river.

Six sand reefs were observed, extending nearly across the river. Some 20 sand bars, a few of which are very large and from 10 to 15 feet in height, are shown on maps. Snags were very numerous, frequently blockading the river, 504 being noted on the maps.

There is no cultivation on the river between Key Corner and Tiger Tail, both sides of the river being heavily timbered. As the mouth of the river is approached several sloughs, ponds, old channels, and Lost Channel are met with.

Surface slope, as taken from Mr. Smith's survey, gives a fall between Key Corner and Tiger Tail of 15.77 feet in a distance of 9.55 miles. In this general description of river much information has necessarily been left out, which will be found on the maps accompanying this report.

1. *Cut-off, one-half mile below Dyersburg* (see sheet No. 1).—This cut-off occurs in the first bend below Dyersburg. This bend, which from head to foot of cut-off is about 1,700 feet in length, has the upper portion of its turn very sharp, the radius being not much over 100 feet, and river only 60 to 65 feet wide; and as there is a strong current at medium stages of water its navigation is difficult and has caused a demand for the cut-off.

The cut-off was started in 1876 by the county authorities, who cut a ditch 3 feet square across the neck of the bend. This was not done with a first view to improve the river, but simply to reduce, during high stages of the river, the volume of water striking the levee upon which the county road is built. This levee approaches within 200 feet of the river (see map). Since then the river has eroded this cut-off to its present size.

The cut-off is 325 feet in length, 70 feet in width between tops of banks, and is almost cut through, as can be seen on the cross sections. The material is alluvium, rather compact on the surface, and as it approaches the water's edge changes to a stiff mixture of blue clay and sand, not very easily eroded.

At time of survey the bottom of cut-off was less than 18 inches above extreme low water, and for a short portion was level with the water. The amount of erosion done during last winter is reported variously as having been from 1 to 2 feet in depth.

According to instructions received, the examination was to be made with a view of straightening the river one-half mile below Dyersburg. As the cut-off is now almost an accomplished fact, I have no recommendations to make in regard to the improvement, except to let the river take its course, as at the present rate of erosion the cut-off will probably be completed by the end of the season. Boats use the cut-off at a 6-foot stage of water. There is at extreme low water a difference of level of 0.60 foot between head and foot of cut-off, which can not help but modify injuriously the channel in the upper pool as soon as the river runs through its new channel.

Caney Point Shoal—7.15 miles below wagon bridge at Dyersburg (sheet No. 2).—This shoal occurs at a portion of the river which is a cut-off of a former river bend (Caney Island Cut-off), and is due to local conditions.

This shoal is composed of sand, débris, snags, and embedded trees, now obstructing the river for a distance of 200 feet and giving only an available depth of about 1 foot 4 inches at extreme low water.

The presence of the shoal at this point is explained somewhat as follows:

The river arriving at this point and turning at more than right angles from its former direction, strikes the opposite bank, or concave side of the bend, with great force at high water, causes considerable erosion of the bank, and in addition an eddy of great violence is produced. This eddy has eroded the bottom in an ellipsoidal form to a depth at lowest water of 23 feet, and to very abrupt outlines.

Upon resuming its course the river, having lost much of its initial velocity, deposits the coarsest portion of detritus just torn from its banks and deposits it immediately below, thus causing the shoal.

As the river falls, snags, logs, etc., are stopped by the high bottom, become embedded, increase the permanency of the obstruction, and render navigation impossible or dangerous.

Dredging of this shoal would only prove a temporary benefit and is not recommended. The only thing which is recommended for the improvement of this shoal is a thorough removal of all embedded snags, logs, or other débris, which will not only get rid of such dangerous obstructions, but also allow the water to cut deeper into the shoal. Additional data will be found on the map.

Basin No. 1—11.95 miles below wagon bridge at Dyersburg (sheet No. 3).—This basin consists of a sudden lowering of one of the banks of the river for a short distance, thus forming an opening through which the river flows sideways and fills a depression, which, owing to its form has been called a basin. (See map of Basin No. 1, sheet 3.) This basin is pear shaped, some 600 feet long, the opening in river being 200 feet wide; its depth, which is diminishing, averages approximately 1 foot 3 inches.

The portion of river adjacent to basin is to some extent shallower than usual, having 3 feet of water in the channel. As the effect of this diversion of the current into the basin produces a retardation of velocity, and consequently causes a deposit of particles just held in suspension, it seems as if the closing of the opening of this basin would have some beneficial effect upon the depth of water in its neighborhood.

It has been thought that if the snags in the immediate vicinity, when removed, were carried across the opening or even inside the basin that the process of filling in of the basin by deposits would go on more quickly, and this is therefore the method of improvement proposed for this location. No dredging proposed here.

Basin No. 2—12.40 miles below wagon bridge at Dyersburg (sheet No. 3).—This basin, just a half mile below Basin No. 1, is very similar in every respect, but is smaller, being about 300 feet long, with opening 125 feet wide and a mean depth of 2 feet in the center. The river adjacent is in fair condition, with an available depth of nearly 3 feet, and with the exception of snags would not call for special notice.

The remedy proposed for this basin is removal of all snags and transportation of same across opening of basin.

The mean of five discharge observations at this location at a stage of 0.12 foot above low water gave 463 cubic feet per second. No dredging is proposed.

Six Mile Cut-off—13.45 miles below wagon bridge at Dyersburg (sheet No. 3).—This is the Cut-off No. 2 of Mr. Smith's survey; the name of Six Mile Cut-off has been preserved, it being the only name by which this cut-off is known among river men.

As may be seen on the map, the river makes here a sharp bend of only 200 feet radius and narrows down in one place to a width of 60 feet.

We find a depth of water of only 2 feet in several places; also many snags and embedded trees. We also find across the neck of the bend a cut-off from 40 to 65 feet wide and 500 feet long. A considerable amount of water flows through this cut-off, but is much impeded in its flow by numerous snags and embedded trees. At a stage of water of 0.86 above low water it was found that about 14 per cent of the total discharge of the river passed through it.

At boating stages of 8 feet or more nearly one-half of the volume of water passes through the cut-off, which is then used by the boats altogether.

The banks of cut-off are alluvium, somewhat sandy; they are low, especially the right bank, which is only 10 feet high. This bank is cutting badly at head of cut-off, while the bank opposite is being built up by various deposits. The right bank is heavily wooded.

The action of this cut-off is at present harmful to the low-water navigation, as, owing to such a large percentage of water being drained through it, a deposit of sand, snags, and other débris is formed opposite the head of cut-off in the main river and for some distance below. On the other hand, this cut-off facilitates navigation as soon as boating stage obtains, as the boats are then able to avoid the short-radius bend, which is very narrow and with very swift current, the distance being also shortened 1,100 feet.

Two ways of dealing with this cut-off present themselves—the first, to close the cut-off in some portion of its length by a low dam of piling, brush, and stone reaching from one bank to the other, this cross dam to be not over 2 feet above low water. This simple and inexpensive method would confine the water to the main river, which, after removal of snags now in the way, would certainly be much improved.

The great and, I think, fatal objection to this method would be that as soon as the river rose a few feet the right bank would immediately begin to cut and cave around the end of the dam, the current would then be much accelerated around this end by the action of the dam itself, and the cut-off would become much enlarged, thus almost certainly destroying the value of work done a few weeks at most after its erection and without having effected any benefit to navigation, which at low water is entirely suspended.

This method has frequently been used on river work, but has, in my experience, been uniformly followed by the same disastrous results; and, in the end, nature has always had her way.

Another method of dealing with the difficulty would be to assist nature by removing those obstructions which retard the completion of the cut-off, and this is the method recommended.

As we have seen, those obstructions consist of snags, embedded large trees, and logs now lodged in the middle and at lower end of cut-off.

The plan proposed consists of a thorough removal and destruction of all the snags, embedded logs, and trees now in the cut-off, and of assisting by means of shovels, hoes, and other implements the erosive action of the stream which will follow upon the removal of each snag. In addition, all the trees on the island, for a zone parallel to the bank and at least 50 feet wide, should be cut down and sawed in small sections, to be destroyed if practicable. Should a dredge boat be available, this could be used in connection and the improvement completed more expeditiously. As there is a fall of 0.42 foot from head to foot of cut-off, it is felt that this will materially assist in the erosion.

The work should be begun early in the low-water season, in order that cut-off may have time to enlarge to such an extent as not to readily retain future snags passing through it.

There are one or two objections to the cut-off. There being a fall of 0.42 foot from head to foot, the upper pool will be lowered to a large extent as soon as flow of water through new channel is unimpeded; secondly, the material eroded from cut-off will be deposited somewhere downstream, and possibly emphasize McCoys Shoals, one-half mile below this point.

McCoys Shoals—14½ miles below wagon bridge at Dyersburg (sheet No. 3).—This shoal is connected with a basin very similar in all its characteristics to Basin No. 1 and Basin No. 2, but with a smaller average depth of water in the channel, the available depth being only 2 feet 2 inches.

The bottom of river consists of loam and shifting sand, which, it is thought, are deposited in a manner similar to that described for Basin No. 1 and Basin No. 2. It is thought also that much of the material deposited is derived from Six Mile Cut-off, less than three-fourths of a mile up the river.

A few bad snags are found in the channel, while the right bank is literally lined with snags and drift, extending in the river, as shown on map.

The plan of improvement proposed at this place consists of a thorough removal of all the snags and drifts and depositing same in basin, now rapidly filling up.

This concludes the report on special examinations.

There are several other points where the conditions are just as unfavorable, and even more so, but no special examination could be made, as the funds allotted for the work did not permit.

ESTIMATE.

It is impossible to present an accurate estimate of the cost of completing the improvement of the river examined. In general, it is not believed that the river can be definitely improved so as to give assured low-water navigation, especially so on account of the difficulties in regard to the portion of river below Key Corner.

It is, however, believed that a thorough clearing of snags for several years will remove the greatest impediments to navigation, and will certainly not decrease all the depth of water which the river is susceptible of giving.

I also infer from the size of the boats used, drawing 4 feet and 6 feet, respectively, and from conversations had with river men, that pilots do not desire so much navigation at low water as the removal of snags which prevent them from using their boats for as long a period as the available depth of water would otherwise allow.

It is therefore thought that the employment of a snag boat in connection with a shore party for a period of four or five months every year would, after a while, keep the river in first-class condition.

The expenses of such a boat and party would be approximately $600 per month, so that, considering repairs, a sum of $3,000 per year would be necessary.

COMMERCE.

Although navigation lasts on the average but from five to six months every year, the amount of commerce done on the river is considerable, and is only limited by the low-water season.

It consists mainly of transportation of timber, which is very abundant, and the exploitation of which gives employment to fully 500 men.

Considerable merchandise has also been transported between Dyersburg and Memphis and St. Louis.

Three tugs and one stern-wheel boat with barges have been employed.

Commercial statistics from July 1, 1895, to June 30, 1896.

	Tons.
Corn	350
Beer	120
Merchandise	15
Stave bolts	5,000
Spokes	600
Lumber	62,300
Logs	42,600
Cross-ties	100
Staves	250
Hoops	150
Heading	100
Total	111,585

Since reported, from July 1, 1896, to December 31, 1896.

	Tons.
Lumber	160

Very respectfully, your obedient servant,

O. L. PETITDIDIER, *Surveyor.*

Capt. JOHN BIDDLE.

A A 5.

SURVEY OF MOUTH OF CUMBERLAND RIVER, KENTUCKY.

[Printed in House Doc. No. 283, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 8, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated December 23, 1896, with map,* by Capt. John Biddle, Corps of Engineers, of the result of a survey of the mouth of Cumberland River, Kentucky, made in compliance with the provisions of the river and harbor act of June 3, 1896.

Captain Biddle states that the two channels leading from the Cumberland River to the Ohio River accommodate easily all Cumberland River navigation, and probably all that of the Ohio River which is apt to take this route, and that the conditions in the channel are improving. He therefore sees no reason for further improvements or expenditures at this point for the present, except such as are necessary to keep the present works in condition, and perhaps to extend them somewhat if circumstances require. In this connection Captain Biddle states that the sum of $20,000 should be appropriated for maintenance of works at the mouth of the Cumberland River, to be used whenever necessary.

In forwarding the report to this office Col. J. W. Barlow, Corps of Engineers, the division engineer, concurred in the views of the district officer.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. JOHN BIDDLE, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Nashville, Tenn., December 23, 1896.

GENERAL: In compliance with instructions contained in letter dated office Chief of Engineers, September 5, 1896, I have the honor to submit the report of survey of mouth of Cumberland River, Kentucky, provided for by the river and harbor act of June 3, 1896.

Work was delayed until November in order to make the survey at the lowest practicable stage of water, and also to make use of a party already in the field, so as to diminish cost, in accordance with instructions from the Chief of Engineers.

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*Not reprinted. Printed in House Doc. No. 283, Fifty-fourth Congress, second session.

While at the time of the survey, from November 1 to 16, 1896, the Cumberland River was low, the Ohio River was high for the time of year and did not get to a low stage at that point during the season of 1896. It was therefore necessary to do the work at a stage of water of about 6 to 8 feet. This prevented as thorough an examination of the conditions of works as was desired, and gave also probably a somewhat different bottom than would have been the case at extreme low water. I believe the survey, however, gives all the information necessary for the purpose.

The survey was made under the personal charge of Mr. B. F. Cheatham, surveyor, with transit and stadia, the soundings taken from a rowboat, the location being determined by the stadia. Observations were taken for discharge, but on account of the water of the Ohio backing up the Cumberland, causing pools and eddies, the discharge of the latter could not be satisfactorily ascertained.

* * * * * * *

The Cumberland River empties into the Ohio near Smithland, Ky. For about 25 miles above its mouth it forms a deep pool, with but little fall and with plenty of water for boating purposes.

The Ohio River about 1 mile above the Cumberland is divided into two branches by Cumberland Island. The greater part flows to the right of the island. The remainder flowing to the left forms what is called the Kentucky Chute. The Kentucky Chute is but 500 feet wide, while the main river is half a mile wide. Into this chute empties the Cumberland River, and the two combined flow past Smithland and join the main Ohio about 2 miles farther down, at the foot of Cumberland Island.

There are thus two outlets from the real mouth of the Cumberland at Smithland to the Ohio River, one at the upper end and the other at the lower end of Cumberland Island. Occasionally, due to sudden rises in the Cumberland while the Ohio is low, the current will flow out from the Cumberland through both channels. If the Ohio be high while the Cumberland is low, the water is backed up a considerable distance in the Cumberland above Smithland, forming a currentless pool.

For improvement purposes the mouth of the Cumberland has generally been considered to be at the foot of Cumberland Island, as most of the commerce of the Cumberland goes naturally through this passage.

A specific allotment of $30,000 was made by act of September 19, 1890, from appropriation for improving Cumberland River below Nashville, for expenditure at the mouth of the river, all of which has been spent below Smithland.

I have, however, had the survey made to both ends of Cumberland Island and out into the Ohio, so as to more thoroughly examine the conditions.

Formerly the channel of the Ohio river at low water was down the Kentucky Chute. A dam built at the head of the island diverted the water into the chute. Subsequently, about 1878, the dam was removed and the channel changed to the right bank. During the past season the Kentucky Chute has again been used by the Ohio River steamboats at low water. This channel would always, however, be too narrow and crooked to successfully pass large tows. After the dam at the head of the island was opened a gradual shoaling took place in the chute near the foot of Cumberland Island. The water of the Cumberland, even with the addition of some Ohio River water, was not sufficient to keep the channel deep. This shoaling increased so as to often make it impossible for a steamboat to pass from one river to the other at stages when both were navigable. Short check dams were tried as remedies, but did not prove successful.

On April 17, 1888, the engineer officer in charge of the Cumberland River reported to the Chief of Engineers the unsatisfactory condition of the mouth of the river. A Board of Engineers was in consequence constituted, which examined the locality and reported on June 16, 1888. These reports are printed in Report of Chief of Engineers for 1888, pages 1626 et seq. The Board thoroughly discussed the subject, and attention is respectfully invited thereto.

The Board recommended that a dike be built beginning at a point on the main shore, about 1½ miles below Smithland, which dike was to cut off a small channel to the left of a towhead, and then to extend along the towhead and beyond foot of Cumberland Island to deep water in the Ohio, reducing the width of the bed to about the normal width of the Cumberland proper above Smithland. The water would be forced to flow between the dike and Cumberland Island, and would presumably cut out the bar. The island would probably have to be protected. The estimated cost was $129,600, which did not include the cost of protection of Cumberland Island. It was recommended that a pile dike be built, cut off to low water, surmounted by crib work to a height of 8 feet above low water, and the height to be subsequently increased if it were found necessary.

The dike has been built as directed, but was made without the crib work, principally because most of the dike had to be built on the towhead, which was itself several feet above low water, and therefore the cutting off to low water became unnecessary and impracticable. The dike has about the height contemplated, but is all pile work filled with brush and rock. There is a gap in the dike about the center of its length, as the towhead comes to the top of the piling and fills the gap. It is possible that this may be cut away, and must therefore be watched. It has not done so as yet. The amount expended was $23,716.71, and the results obtained are those sought for under the project and estimate of $129,600.

In the Report of the Chief of Engineers for 1896, pages 1907 and 1908, the following statement is made with reference to this dike:

> The dike as at present constructed, however, secures the object sought after; that is, the passage from Cumberland River to the Ohio. Bars form in the Ohio River opposite the mouth, beyond the end of the dike. These bars shift continually, but there has never been any difficulty in passing from one river to the other since the dike has been completed, while previously the mouth was often closed while each river remained navigable. It seems probable that some time the gap in the dike will have to be protected. With that in view, and also to ascertain effect of dike, surveys have been made each year to determine the changes that occur. Up to the present no cutting of the towhead has taken place. It is suggested that if this happens it would be well to cover the gap with a layer several feet thick of broken stone extended in front of the line of the dike, so that as the bank cuts away the stone will fall in and make a protection. It is also possible that Cumberland Island will have to be further protected.

Examining now the map of the survey made this season, it will be seen that at a 7 to 8 foot stage there is a good and sufficient channel from Smithland to the Ohio, at the lower end of Cumberland Island, of a depth of about 12 feet, and to the head of island of a depth of 11.5 feet.

Cumberland River navigation is by boats which never draw, except perhaps occasionally, more than 5 feet, and at river stages below 2 feet do not carry over 2½ to 4 feet, and usually not as much. It is therefore seen that these channels will accommodate easily all Cumberland River navigation, and probably all that of the Ohio River apt to take this route. Moreover, the conditions in the channel are improving.

Therefore, I see no reason for further improvements or expenditures at this point for the present, excepting such as are necessary to keep the present works in condition, and perhaps extend them somewhat if circumstances demand. There should, therefore, be a sum of perhaps $20,000 appropriated for the work at the mouth of Cumberland River, Kentucky, for "maintenance," to be used whenever necessary. The works are as permanent as such works are usually made, but are of timber and must be kept in repair; also, due to shifting channels, deposits, and cuttings, some changes may become desirable and further protection to the banks obligatory. Besides, it may become necessary to protect the gap in the dike.

Therefore, no further improvements are recommended to be undertaken at present, but that a careful watch be kept over this locality and from results observed further action be taken when it shall become necessary.

Very respectfully, your obedient servant,

JOHN BIDDLE,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

APPENDIX B B.

IMPROVEMENT OF TENNESSEE RIVER AND ITS TRIBUTARIES.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Tennessee River.
2. Operating and care of Muscle Shoals Canal, Tennessee River.
3. French Broad and Little Pigeon rivers, Tennessee.
4. Clinch River, Tennessee.

SURVEYS.

5. Mouth of Tennessee River, Kentucky.
6. Emory River, Tennessee.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., July 8, 1897.

GENERAL: I have the honor to transmit herewith my annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

THE DISTRICT.

This district was in charge of Capt. Dan C. Kingman, Corps of Engineers, during the entire year. The division engineers were Col. J. W. Barlow, Corps of Engineers, until May 7, 1897, and since then Col. Henry M. Robert, Corps of Engineers.

TENNESSEE RIVER SYSTEM.

The Tennessee River receives its water from seven different States, namely: Virginia, North Carolina, Georgia, Tennessee, Alabama, Mississippi, and Kentucky. The total area drained by it is 44,000 square miles, an area almost equal to that of England. It discharges in time of floods not less than 700,000 cubic feet of water per second, and even at its low stages its discharge each second is 10,000 cubic feet.

The following table gives the length of the Tennessee River and of the navigable portion of its tributaries, so far as it is known. There has been no general survey to cover this system, and the length of the navigable portion of most of the tributaries has been determined from old reconnoissances and from the statements of pilots and others engaged in the navigation of these streams. For this reason it is probable the distances in some cases are overestimated. In a number of cases it has been impossible to ascertain the length of the navigable portion of tributaries, but sufficient information has been collected here to show that the system has over 1,382 miles of water navigable by steamboats and nearly 1,053 more navigable by rafts and flatboats, making in all a system of internal waterways of the United States 2,435 miles in extent.

Name of stream.	Navigable by steamboats to—	Miles.	By rafts and flatboats on up to—	Miles.
Tennessee River	Holston and French Broad	643½		
Clark River	The Forks	15	Benton and Clear Springs.	50
Big Sandy River	Marble Quarry	20		20
Duck River	Centerville	68	About Columbia	50
Buffalo Creek		Unknown.		Unknown.
Beech River		40		Unknown.
Yellow Creek			To near Memphis and Charleston Road.	12
Bear River	About Crippled Deer Creek	16	Burleson, Ala	34
Blue Water Creek	To Rock House	2		Unknown.
Elk River	Fayetteville, Tenn	75		Unknown.
Limestone Creek		2		
Cotaco Creek		7		
Flint River				40
Paint Rock Creek				50
Guntersville Creek				15
Sequatchie River	To Chattanooga and St. Louis Bridge.	12		63
Short Creek		5		
Town Creek		8		
Chickamauga Creek		2		23
Hiawassee River	Savannah Ford	33		67
Clinch River	To mouth of Powell River	100	Osborn Ford	220
Emory River	Railroad bridge	14		
Powell River			Mouth to Shavers Ford, Va.	100
Little Tennessee River	Water Lily Schoolhouse	40		60
Tellico River	Hawkins Mill	6		30
French Broad, Tennessee.	Leadvale	70		Unknown.
Little Pigeon River	Catlettsburg Warehouse	2	Sevierville	3
French Broad, North Carolina.	Brevard to Asheville	48		Unknown.
Holston River	Kingsport, Tenn	154	Saltville on North Fork 90, South Fork 25.	115
Nolichucky River			Henleys Ford	101
Total		1,382½		1,053

Not all of this system is under improvement. Indeed, the improvement has generally been limited to the main trunk of the river and three or four of its tributaries. Less than 550 miles of the 2,435 miles have been surveyed, and no project has ever been formed for the improvement of the system as a whole. A general survey of it is very desirable, not only to secure a thorough knowledge of its regimen, to determine its susceptibility of improvement, and to prepare plans and estimates for work to be done, but also to fix upon and determine the head of navigation of each of the tributaries, in order that they may be better protected from unlawful obstruction and interference and that the bridges built over them may have proper supervision by the War Department of the United States.

The United States early recognized the value and importance of this system of waterways, and in 1828 gave to the State of Alabama 400,000 acres of public land within its borders, to be sold and the proceeds applied to the improvement of the river. This was only nine years after Alabama was admitted to the Union. As early as 1827 the United States made an appropriation of money for the survey of a portion of the Tennessee River, and in 1852 it appropriated $50,000 for its improvement. Since then other appropriations of money have been made by the General Government, until more than $5,200,000 have been applied to the improvement of this river system, and plans for its further improvement have received the sanction of Congress which will require the expenditure of over $6,000,000 more.

The river is not now navigable during the entire year, but the improvements which have already been made are sufficient to demonstrate that the main trunk of the river can be made navigable throughout the year and that the season of useful navigation can be greatly lengthened on all of the tributaries. Owing to the fact that in general the bottoms of these water courses are hard and their banks stable, and from the fact that they are seldom obstructed by ice, they are exceptionally susceptible of improvement. Notwithstanding the many obstructions which still exist in the river and the difficulties and dangers of navigation, there were 64 steamboats, of an aggregate tonnage of 10,000 net tons, and 240 barges, of a carrying capacity of 80,000 tons, employed during the year 1896 upon this river system. In addition to these means of transportation, a large amount of lumber was floated down the river in rafts and a considerable quantity of material was moved in flatboats. In regard to the latter method of transportation no record could be obtained, but the statistics actually collected show that there were transported upon the river during the year above mentioned more than 100,000 passengers and nearly 2,000,000 tons of freight, valued at $22,000,000.

The methods which have been adopted for improving the navigation of the Tennessee River and its tributaries, so far as the improvement has gone, are as follows: First, by the removal of snags, wrecks, overhanging trees, and loose rocks and bowlders obstructing the channel; second, by dredging; third, by the construction of wing dams and training walls, and fourth, by the construction of lateral canals.

The removal of snags and similar obstructions is of course always a successful improvement as far as it goes. Snags and leaning trees appear again, however, so that this improvement is never entirely completed. Dredging, when properly planned, and when made through hard material, is generally a permanent improvement, but the mere dredging through bars of recent formation composed of material light enough to be moved by the water is apt to be temporary, and the benefit resulting from it is soon lost.

Before discussing the other two methods of improvement it is well to briefly describe the channel of the bed of the Tennessee River, and a description of that of the river itself will apply pretty well to all of its tributaries. If the bottom of the Tennessee River should be laid bare so that it could be examined, it would be found not to consist of a smooth, even groove or furrow like a ditch, but rather of a series of long and narrow and deep holes or troughs, these holes being separated from each other by ridges, which are generally broad and flat on top and of such length as to make the river considerably wider where they occur than it is at the deeper pools. The crest of any one of these ridges is generally a little lower than that of the one which immediately precedes it upstream. These ridges are generally composed of hard material, such as cemented gravel, loose rocks of considerable size, or more often of solid ledges, and are, in short, the bars or reefs and are the places where in low water navigation is most inconvenient and difficult. They are found at the places where the bottom of the river is harder and offers more resistance to erosion than the banks, and where, in consequence, the river in its effort to secure a channel sufficiently commodious to carry its flood discharge has cut away the banks instead of the bottom, naturally selecting the softer material.

In low water, then, the river is made up of a series of narrow ponds or pools, varying from a few hundred yards to several miles in length, in which the water is deep, the current gentle, and navigation generally free and unobstructed, these pools being separated by bars where the river is wide, the water shallow, and the current rapid, where islands frequently occur and divide and subdivide the channel, and where nearly all the fall is concentrated, where snags and bowlders are generally found, and where navigation is in consequence difficult, often dangerous, and sometimes impossible. This is the condition at low water.

When the river rises, the gain in cross section is greater on the wide bars than it is in the narrow pools, and consequently the area of discharge increases more rapidly on the bars than it does in the pools; the area of the cross section of discharges on the bars rapidly approaches that in the pools and finally equals and then exceeds it. As a result the conditions with respect to the velocity of the current are reversed in high water and the current becomes gentle, comparatively speaking, where before it was most rapid and swift. For this reason gravel, bowlders, sunken logs, and other débris are scoured from the bottom of the pools at high water and often deposited on the bars, where it remains when the river falls, the feebler currents due to the low water discharge not being adequate to remove it.

The method of improving the river by wing dams and training walls generally has for its objects to raise the water surface and to secure a more uniform disposition of the slope on these bars at low stages of the river. It is a very easy thing to close by a dam an island chute, and thus force all of the low-water discharge through one of its natural channels, or, in the absence of an island, to construct a wing dam and training wall which will in effect crowd the discharge toward one side of the river. This always deepens the water where before it was shallow. An examination of the Tennessee River, particularly that portion above Chattanooga and of such of its tributaries as have been worked on in the past, shows that a great deal of this kind of work has been done. But it is always a very dangerous thing to interfere with the established regimen of any river. Works of this kind have almost invariably had the following effect: They have first robbed a portion of the bed of the river of its water to crowd it into another portion, and the effect has been to lower the water surface at the lower end of the chute, and thus simply transfer the difficulties to that point. If the artificial passage has terminated in water that was naturally deep, then the expansion and spreading out of the water as it leaves the foot of the chute has caused a loss of velocity, which has almost invariably led to the formation of a bar, which not infrequently proves a worse obstruction than the one which the improvement was designed to overcome.

I am very far from saying that wing dams and training walls are not desirable methods of improving a river of this kind, but they must be located with the greatest care, with a view to the natural condition of the river at the point to be improved, they must produce as little disturbance of the regimen as possible in order to secure the desired result, and arrangement must be made to compel the water on the falling stage of the river to cut away the bar which will be pretty sure to form at high water. Therefore all such improvement must be made after close study, the work must be carried on slowly, extended over three or four seasons, the changes carefully watched, and the defects remedied; and even then it can not positively be said that the improvement will be a permanent one.

The method of improvement by lateral canals has been carried out at Elk River Shoals, at Big Muscle Shoals, and is in progress at Colbert Shoals. It is also proposed for Little Muscle Shoals. This improvement can always be made perfectly successful and highly satisfactory. It is expensive to make and expensive to operate and maintain, but, if the commerce will justify it, is always worth what it costs.

The method of improvement by slack-water navigation—that is, by locks and dams—has not yet been applied to the Tennessee River system, though many of the tributaries and even the upper portion of the main trunk are admirably adapted to this form of improvement.

For the purposes of appropriation and administration the river system has been subdivided so as to separate the main trunk from the tributaries and to divide the main trunk into two sections, namely, the portions lying above and below Chattanooga, Tenn.

B B 1.

IMPROVEMENT OF TENNESSEE RIVER.

[Length, 640 miles.]

The junction of the Holston and French Broad rivers, 4½ miles above Knoxville, is now generally taken as the head of the Tennessee River, and in the river and harbor act of 1890 this point appears to have been definitely fixed by the specific language of the act providing for a survey of the Tennessee River from Chattanooga to the junction of Holston and French Broad rivers.

As one of the largest of the fifty-three or more tributaries of the Mississippi River the Tennessee has always held an important place in the projects for the improvement of the navigable waterways of the country. The Muscle Shoals Canal having been opened to navigation, the Tennessee River is now navigable from its source to its mouth, a distance of 640 miles, during several months of the year, and as work is continued upon certain other less formidable obstructions the season of navigation will be correspondingly lengthened. The radical improvement of this river so as to make navigation continuous throughout its entire length for boats of moderate draft is by no means an impossibility.

Now that the great obstruction of the Muscle Shoals has been overcome by the completed canal, and Colbert Shoals is in process of being done away with in the same manner, it is more annoying to the now really brightening prospects for river navigation to have to contend with the smaller obstructions which exist in a number of places along the river. These obstructions are very short in length, but no whit less obstructive than the longer ones.

1. ABOVE CHATTANOOGA (188 MILES).

This section of the river is navigable except during the periods of very low water which occur during the summer and fall months; at such times navigation can only be carried on with very small and light-draft boats, excepting during the occurrence of the so-called "rain tides."

The commerce of this portion of the river is carried on by means of steamboats carrying freight and passengers, and generally towing one or more barges; by flat-boats descending with the current from the upper tributaries, and by rafts of lumber and logs. The latter constitute an important part of the commerce of the upper Tennessee River.

In 1830 Col. S. H. Long, United States Topographical Engineers, made a careful examination of the Holston and Tennessee rivers between Kingsport, Tenn., and the Alabama State line. His report, published as House Ex. Doc. No. 167, Forty-third Congress, second session, gives a detailed descripition of every obstruction to navigation at that time, and plans and estimates for their improvement. In 1871 an examination was made between Knoxville and Chattanooga under the direction of Maj. Walter McFarland, Corps of Engineers. (See Reports of Chief of Engineers, 1871, pp. 502–507, and 1872, pp. 488–494.) The obstructions to navigation, as described in these reports, were "low-water obstructions," consisting of bars, either rock or gravel, extending across the river, with lengths varying from 60 feet to 2 miles, the depth of water over these bars varying from 10 to 30 inches at extreme low water, and the current varying from 2½ to 6 miles per hour.

The bed and banks of the river are of such character as to make any improvements more or less permanent, with the exception of the removal from time to time of such drift or snags as may be brought down by the annual floods.

In 1832 the State of Tennessee undertook the improvement of certain points above Chattanooga by removal of rock and construction of wing dams, but there is no record of the work done, and it did not prove of lasting value.

In 1871 an examination was made and upon it a project of improvement based, which provided for the removal of snags and drift and for deepening the channel at the worst obstructions by blasting and dredging or by scouring the bars by the aid of wing dams, to an extent that will secure a channel 3 feet in depth at average low water, and at an estimated cost of $340,000. The estimate of 1871 was increased in 1874, 1877, 1884, and 1891, for the reasons stated in the reports of those years.

Under the provisions of the river and harbor act of September 19, 1890, a "careful and comprehensive survey" of the Tennessee River above Chattanooga was made "with a view of ascertaining to what extent the navigation of the river is capable of improvement, and the cost of the same and the preparation of suitable plans therefor." This survey was begun in May, 1891, and completed during the fiscal year 1893. The report, with estimate and plans, was submitted to the Secretary of War in February, 1893, and forms House Ex. Doc. No. 252, Fifty second Congress, second session. The plan of improvement proposed was the same as that formerly in progress, as above stated; that is, to obtain a 3-foot low-water navigable channel between Chattanooga and the mouth of the French Broad River, at an additional estimated cost of $650,000. The project based on the survey of 1891 received Congressional approval in the river and harbor bill of August 17, 1894.

Eighteen appropriations have been made by Congress for this work, aggregating the sum of $361,000, viz:

Act of—		Act of—	
April 10, 1869	$35,000	August 2, 1882	$7,000
June 10, 1872	25,000	July 5, 1884	3,000
March 3, 1873	25,000	August 5, 1886	7,500
June 23, 1874	25,000	August 11, 1888	15,000
March 3, 1875	40,000	September 19, 1890	30,000
August 14, 1876	15,000	July 13, 1892	25,000
June 18, 1878	15,000	August 17, 1894	50,000
March 3, 1879	11,500	June 3, 1896	15,000
June 14, 1880	10,000		
March 3, 1881	7,000	Total	361,000

The total amount expended, including outstanding liabilities, to June 30, 1896, was $321,290.82.

This expenditure has resulted in giving a lengthened season of navigation and an improved channel at 29 of the 43 obstructions enumerated by Colonel Long in his report of the examination made in 1830. The work has also resulted in rendering the general navigation of this portion of the river safer and easier, and has permitted a reduction in freight rates. The work has consisted in some cases of the removal of bowlders and the excavation of rock and gravel in the channel. This style of improvement, where not too expensive, is desirable and can as a rule be safely made. The size of the channel which it is necessary to excavate bears such a small proportion to the entire area of cross section of the river that no injurious lowering of the upper pool results. By far the greater part of the work done, however, has consisted in the construction of wing dams and retaining walls, designed to elevate the surface of the water on the shoals, to equalize its slope and consequent velocity. Work of this kind has been remarkably permanent, very little that has ever been built has been destroyed. The improvement, however, resulting from this work has not always been equally permanent. As elsewhere described, the tendency of such work is to form a bar at the lower end of the chute and to transfer the difficulties down stream. The work built, however, is generally valuable and by proper extensions and the construction of spurs to assist the low-water current in cutting through the bars can be made valuable for a permanent improvement. The improvements made at White Creek Shoals and Soddy Shoals were judiciously planned and have stood the test of several years' trial, and appear to be permanent and satisfactory.

During the past season work has been in progress at Caney Creek Shoals. Most of the work done consisted in removing rock reefs from the channel, or rather from a new channel which had been laid out; 2,781 cubic yards of solid rock was removed in the course of this work. Great care has been observed to remove all of the rocky points which projected above the bottom and which might injure boats seeking to use the full depth of water in the channel. Buoys were placed to mark the channel and targets erected on the bank. The longitudinal dam was extended 420 feet downstream, and a spur, 80 feet long, was constructed at the lower end. At the lower end of the excavated channel a natural reef was added to, so as to form a low dam 877 feet long, which was designed to hold up the water in the pool and to prevent any lowering due to the excavated channel. Some dredging was also done near the upper end of the shoals to remove a bar, which was formed, in my opinion, by the eddy caused by an old dam which does not now form an essential part of the improvement. The dredge dipper was received too late in the season to give it a good trial.

The floating plant belonging to this section of the river had never been docked since it was built, and accordingly in the latter part of December, 1896, it was all sent to Muscle Shoals Canal and there docked, painted, and otherwise repaired. At about the end of May, 1897, a portion of the fleet was sent up the river in tow of the U. S. towboat *Colbert*. Owing to low water, however, the *Colbert* was not able to get above Lenoir City, Tenn., 46 miles below Knoxville; it returned and took the rest of the fleet to this point. The repairs to the towboat *Stephen H. Long*, belonging to the upper river, had not been completed at this time; it was found necessary at the last moment to exchange its boiler for another one, which was on hand, the original boiler showing rather badly under test. As soon as the repairs to the *Long* were completed it was sent to Lenoir City and took the fleet to Knoxville, arriving there with the last tow about the end of June.

It was proposed last year to complete the permanent improvement proposed at Knoxville this spring, but owing to the fact that the county was replacing its bridge across the river by another close by, the channel was temporarily very much obstructed and the time unfavorable for completing the improvement. The builders are required to entirely remove the old bridge, including its piers, as soon as the new one is finished. It was thought last year that the new one would be finished by this time, but it is not; for that reason there are two sets of piers in the river, and as the spans are different it is greatly obstructed, although no complaints in regard to it have been received from the owners of vessels navigating this portion of the river. Work done at Knoxville at this time will therefore consist simply of removing the remains of some old bridge piers and repairing the wing dams and training walls. The fleet will then be sent to work for a few months on the French Broad River, and on its return, if the bridge has been completed and the old one removed and the conditions are favorable, it will complete the work at Knoxville.

For further details in regard to work done, and for map showing the work done at Caney Creek Shoals during the past year, attention is respectfully invited to the report of Superintendent R. R. Thacher, which is transmitted herewith.

Money statement.

July 1, 1896, balance unexpended	$41,241.37
June 30, 1897, amount expended during fiscal year	19,330.06
July 1, 1897, balance unexpended	21,911.31
July 1, 1897, outstanding liabilities	1,532.19
July 1, 1897, balance available	20,379.12
Amount (estimated) required for completion of existing project	585,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	65,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

2. CHATTANOOGA, TENN., TO DECATUR, ALA. (145 MILES).

The most serious obstructions to navigation found upon this section of the river are situated in the mountain region immediately below Chattanooga. For about 25 miles the river is rigidly confined by the mountains; its channel is crooked and exceedingly narrow. The fall is very rapid, and the strong current which results is a most serious obstruction to navigation. In 8½ miles of this distance there is a fall of 16½ feet. Considerable work has been done in widening the cross section of the low-water channel by the removal of bowlders, projecting rocky points, and overhanging trees. This has resulted in somewhat diminishing the velocity of the current and equalizing the fall, but the upstream navigation is still attended with delays, caused by the necessity of laying lines and warping vessels over the swiftest places. It is impossible to diminish the slope by a development of the channel, and the limit of improvement by channel work is very soon reached. When the great obstructions at Colbert Shoals and Big and Little Muscle shoals have been completely overcome by canals, the greatest difficulties and dangers to navigation on the river will then be encountered in this mountain section. Bars and reefs and shoal water elsewhere cease to be obstacles when the river attains a sufficiently high stage, but in the mountains the current increases with the rise of the river, and there is no stage at which navigation is good.

This stretch of river could undoubtedly be improved by the construction of one or more dams with locks, thus dividing it into pools. The locks of course could not be operated at extreme high water; at a certain determined stage it would be necessary to permit the dams to be drowned out, the locks submerged, and to require navigation to follow the open river. This method of improvement has received some consideration in the past, but the very considerable cost of the improvement has told against it.

After the river passes the mountains its character changes, and from thence down to Decatur the river is generally wide and shallow, with a gentle slope. The obstructions are broad, flat bars, sometimes composed of solid rock, but more often of hardpan, in which large bowlders are embedded; at other places the obstructions are rock reefs. The veins of blue flint, which were embedded in the rock which forms the bottom of the channel, have been exposed by the erosion of the softer rock adjacent until they stick up a foot or more above the general level of the bottom. They are usually inclined, but sometimes nearly vertical. They can be blasted off and a limited improvement thus obtained.

The United States dredging plant, consisting of the stern-wheel towboat *McPherson*, the *Harwood*, an Osgood dipper dredge, a 12-horsepower steam derrick boat, and four barges, was employed during the greater part of the season upon the river between the mountains and Decatur. The following work was done:

At Bridgeport, immediately above the drawbridge, 820 cubic yards of rock, clay, and gravel was dredged from the channel, and 285 cubic yards of rock was blasted and removed by the derrick boat. The work, with that heretofore done, forms a channel through this bar 1,400 feet in length, 100 feet wide, and 2½ feet deep in the shallowest portion at that extreme low water.

The greater part of the channel is much deeper than this, the shoal part being due to the existence of some rock which it was not possible to remove, owing to the lateness of the season.

At Widows Bar, 5 miles below the bridge at Bridgeport, there exists an extensive shoal; the length of the shoal water is about 3,000 feet along the channel, but it is crossed near the head by 10 or 12 projecting, flinty reefs which stick up 12 or 15 inches above the general bed of the river. There is only about 8 inches of water over some of these reefs at the extreme low stages of the river. The excavation of the channel through this entire bar was too great a work to be undertaken at this time, but the reefs were drilled and blasted over a space 80 feet wide and

250 feet long. The broken rock has not yet been removed, but it will be done during the present low water season, and will to the extent indicated improve the navigation over this bar.

At the head of Henrys Island the channel was very narrow and the current quite swift for this portion of the river. There were two large rocks on one side of the channel and one on the other which interfered with navigation. These rocks were drilled and blasted off so as to afford a sufficient depth over them.

At Beards Reef, just below Guntersville, a channel 120 feet wide and 550 feet long was drilled, blasted, and dredged completely through the reef, thus giving a channel 3 feet in depth at extreme low water. Nearly 10,000 cubic yards of material was dredged from the cut and 190 cubic yards of solid rock was removed with the derrick. This work was very severe on the dredge; some very large pieces of stone were handled by it; one piece weighing nearly 25,000 pounds was brought up and swung out of the channel.

At Flint River Bar, just below the mouth of Flint River, the channel has been changed so as to avoid a very bad crossing. Work had been done at this place in the previous year. A great deal of drilling and blasting has been done. Dredging was done during the past year so as to afford a channel having a minimum width of 60 feet and an average width of 120 feet, with a depth of 3 feet at extreme low water. A small place, about 30 by 60 feet, was not given the full depth for the width of 120 feet because the rock was not sufficiently broken up by the previous blasting to enable the dredge to remove it.

From the foot of Beards Island to Browns Ferry, a distance of 105 miles, the river has never been surveyed and no complete plan has ever been made for its improvement, and no estimate of the entire cost necessary to give a 3-foot navigable channel at extreme low water over it has ever been made. Of course it is impossible to make an estimate without a survey.

For details of the work done on this portion of the river, for general cost of the same and the unit prices, I would respectfully refer to the report of Assistant Engineer W. S. Winn, who was in local charge of the operations.

3. DECATUR, ALA., TO FLORENCE, ALA. (50 MILES).

The principal obstructions upon this section of the river are the Muscle Shoals, extending from deep water at Browns Ferry to deep water at Florence (38 miles) and embracing Elk River Shoals, Big Muscle Shoals, and Little Muscle Shoals. Only 8 miles of this distance of 38 miles is navigable in its natural condition.

The Elk River Canal, a mile and a half long, having two locks having lifts of 12 feet, and from 8 to 11 feet, respectively, overcomes the obstruction at Elk River Shoals.

The Big Muscle Shoals Canal, originally built for the United States by the State of Alabama, which was completed in 1836 and practically abandoned in 1837, overcame the obstruction of the Big Muscle Shoals. This canal was subsequently repaired by the United States, its locks remodeled, enlarged, and given increased lifts whereby their number was diminished, and the whole completed in 1890.

An attempt was made to overcome the difficulties of navigation on Little Muscle Shoals by channel work, but the fall is too great and the limit of the improvement was reached without satisfactory results. The project has since provided for the construction of a canal 15,000 feet long, with a guard lock at the head and a lift lock at the foot, having a lift of 12 feet, to overcome this obstruction.

The Big Muscle Shoals and the Elk River Shoals divisions of the canal permit navigation through them at all stages of the water. Between these two canals there is a stretch of water about 8 miles long which still offers a number of obstructions to navigation. A good deal of work has been done here, but in their present condition these obstructions are sufficient to stop navigation between the two divisions of the canal even before extreme low water is reached. Some work was done on this portion of the river during the past year. Nances Reef, one of the worst of the obstructions, is a long reef extending across the river between the two divisions of the canal. An opening has been blasted through it in the past to permit the passage of boats at low water. After this was done, however, there was found to be a very objectionable cross current, both above and below the reef, which tended to cause a long boat, or a boat with a tow, when descending the river to turn in the cut and be carried against the rocks at its side. To cut off and prevent this cross current a longitudinal dam 500 feet in length was built, during the past season, on the south side of the cut in the reef. The dam contained about 350 cubic yards of stone, but it was not quite completed, because a rise in the river compelled the work to be abandoned before all the rock necessary had been put in place. Even in its unfinished condition, however, it is a valuable improvement, very nearly destroying the objectionable cross current and rendering the passage through the reef very much safer and easier.

At the head of Little Muscle Shoals a similar objectionable cross current was cut off by the construction of a short wing dam containing 130 cubic yards of rock.

At Burkettes Island, about 2 miles above the Elk River Canal, there was a place in the bank which the owner claimed had been caused by the water washing around the end of a temporary dam which had been erected by the United States many years ago when the island chute was under improvement. The washing away of the bank had cut through and lowered the elevated rim which is always found on such islands, and thus permitted the river, when at a sufficiently high stage, to flow with a strong current into the interior of the island, thus washing its surface and tending to fill the drainage ditches which had been excavated upon it. The owner felt that the United States was responsible for the injury inflicted upon his property; the island was very large and fertile. With the approval of the Chief of Engineers the matter was compromised to the satisfaction of all parties in this way: The owner of the island built an earth levee or embankment across the low places, and the United States protected this levee from washing away by riprapping it with stone—about 125 cubic yards of riprap were used for this purpose.

Sweetwater Bar is situated in the navigable chute below the Little Muscle Shoals and between it and Florence. It was formed of the rock and gravel washed out into the channel by a small stream, which in time of heavy rain becomes a torrent, and it had so narrowed the channel as to cause caving upon the island side and to give a great velocity and a bad direction to the current. This bar was removed by dredging, and a part of the material was deposited behind a crib structure which was designed, in connection with a dry stone wall, to form an artificial island which would deflect the water from Sweetwater Creek downstream and make it enter the channel with a direction parallel to the river current. About 8,500 cubic yards of loose rock and gravel were excavated at a cost of less than 20 cents a cubic yard. Two cuts of the dredge were made 1,150 feet each in length, and one 520 feet, thus straightening the channel and reducing the velocity of the current.

A small bar higher up, known as the Wagon Factory Bar, was dredged out in the same way; about 2,000 cubic yards of material were removed.

Immediately below the drawbridge at Florence a bar had made out from the shore which obstructed the passage through the draw. This was removed by dredging, 2,084 cubic yards being taken out.

4. FLORENCE, ALA., TO FOOT OF BEE TREE SHOALS (30 MILES).

Bee Tree and Colbert Shoals, beginning about 22 miles below Florence, form the principal obstructions to navigation during low water.

These shoals, which may be considered as forming one continuous obstacle, are 8 miles in length, with a total fall of 25 feet at low water, at which stage the available depth is about 1.5 feet.

Four islands divide the river through the shoals longitudinally, and the work heretofore carried on for the improvement of navigation consisted in building riprap dams which, in connection with the islands, confined the water to the chute along the north bank. Increased depth was obtained by channel excavation. This method does not give results adequate to the present needs of commerce.

The total amount actually expended on the improvement of these shoals from the beginning of improvement in 1827 to June 30, 1890, including surveys, excavation of rock from the channel, and construction of dams, was $62,243.41.

The project adopted in 1890 contemplates the construction of a lateral canal on the south bank of the river 7.8 miles long, 150 feet wide at the water surface, with a depth of 7 feet. A combined lock, with a total lift of 25 feet, was originally intended to be placed at the lower end and a guard lock at the head, for use when necessary at very high water, the locks to be 80 by 350 feet, with a depth of 6 feet on the miter sills at extreme low water.

This project was modified, after the detailed surveys of 1891 were completed, by substituting for the combined lock two locks of 12 and 13 feet lift, respectively, at extreme low water, separated by a pool 1 mile in length.

This project was again modified in 1892 by the substitution of one lock of 25 feet lift for the two locks contemplated in the project as modified in 1891, retaining the guard lock at the head of the canal.

A contract for the construction of the lift lock at Riverton, Ala., was entered into August 10, 1893, with Tere A. Clark, of Quincy, Ill.

Operations under this contract were continued with ever-increasing difficulties and diminishing results until December 17, 1894, when the contractor ceased all active work, owing to a strike among his employees. The contract was annulled in January, 1895, and by February 1, 1895, the United States had assumed charge of the work. Comparatively little had been acccomplished by the contractor, his efforts having been pricipally confined to excavation of lock pit.

Under the project $149,735.42 was expended up to the close of the fiscal year, June 30, 1895, in making survey of location for canal, purchasing lands necessary for the improvement, examining foundations for both locks, in making detailed drawings and specifications for and purchasing lock-gate anchorages, in making detailed drawings of the lift lock and of special stones and other masonry, in beginning work of designing the guard lock, in bringing a good supply of water to the lock site, in erecting a pumping plant, two stiff-leg derricks, the necessary storehouses and shops, in opening a quarry at Cherokee, Ala., and in general preparations for the establishment of the plant to be used in carrying on the work.

All of the land intended for the right of way has been purchased.

The Annual Report of the Chief of Engineers for the fiscal year ending June 30, 1896, gives a very full and detailed description of the lift lock at Riverton, Ala., which description is illustrated by photographs and drawings, and the specifications under which the work was to be done are fully set forth therein. The nature and character of the materials and plant used and the general methods followed are also fully described. These plans and specifications have been strictly adhered to, and the high standard originally adopted has been maintained throughout.

The masonry of the lock is now practically completed, and it will bear the most critical inspection and comparison with any similar structure.

During the past year 8,519 cubic yards of stone has been quarried and shipped to Riverton, and 31,661 cubic yards of earth and rock has been excavated, thus completing all work of this kind at the lock pit. Two thousand eight hundred and eighty cubic yards of stone has been cut or scappled, and 12,715 cubic yards of masonry has been laid.

AT CHEROKEE QUARRY.

The failure of the upper 30 or 40 feet of the quarry at Cherokee to produce any material suitable for use in the construction of the lock has added greatly to the cost of the stone, making it necessary to handle at least 3 yards of waste material for every single yard of useful stone obtained. Much of the waste material might have been utilized in a more thickly settled portion of the country for building purposes, but it is of no value in the construction of the lock. These quarries were opened in April, 1895. The first shipment of stone was made in August of the same year, and the last in December, 1896. During this time 19,572 cubic yards of stone was produced and shipped to Riverton. The quarries have since been shut down and abandoned. The total cost of operating them has been $100,669.79, or, deducting the present value of the plant, $5,500, there is left $95,169.79 as the cost of the stone produced, which is an average price of $4.86 per cubic yard delivered at the lock site. The actual cost of quarrying the stone has been small when compared with the cost of stripping, handling, freight rates, and the various expenses incidental thereto, the proportion being about 1 to 2½, which clearly indicates the points in which a saving could be made in the construction of the upper lock. For this it will be desirable to find quarries situated upon the river bank, so that water transportation may be used. It will also be desirable to find quarries where but little stripping will have to be done.

The stone obtained from the Cherokee Quarry had the advantage common to sandstone of working very easily when first taken from the quarry. Its weight, however, which was about 135 pounds to the cubic foot, is about 10 per cent less than that of the limestone, and this was, of course, an objection.

Considerable difficulty was encountered in obtaining a good sand for concrete and mortar at a reasonable cost. The first sand used was obtained from Memphis, Tenn., and was an excellent quality of Mississippi River sand. The cost, delivered, was $1.10 per cubic yard. An allowance, however, had to be made for wastage, which somewhat increased the actual price. Owing to an increase of railroad rates, it was found necessary to obtain sand elsewhere, and a certain quantity of pit sand was obtained from Spruce Pine, Ala., but this not being altogether desirable, sand was finally brought from the Ohio River at Paducah, Ky., a towboat and barges belonging to the United States being used for its transportation. About 900 cubic yards was obtained in this way. This was brought at extreme low water, and much valuable information in regard to the navigation of the lower river and the improvements necessary there was incidentally obtained.

All of the limestone coping was purchased from the Fossick Company from their quarries at Rockwood, Ala. It was an excellent quality of oolitic limestone, and cost, delivered and sawed one way, $11.72 per cubic yard.

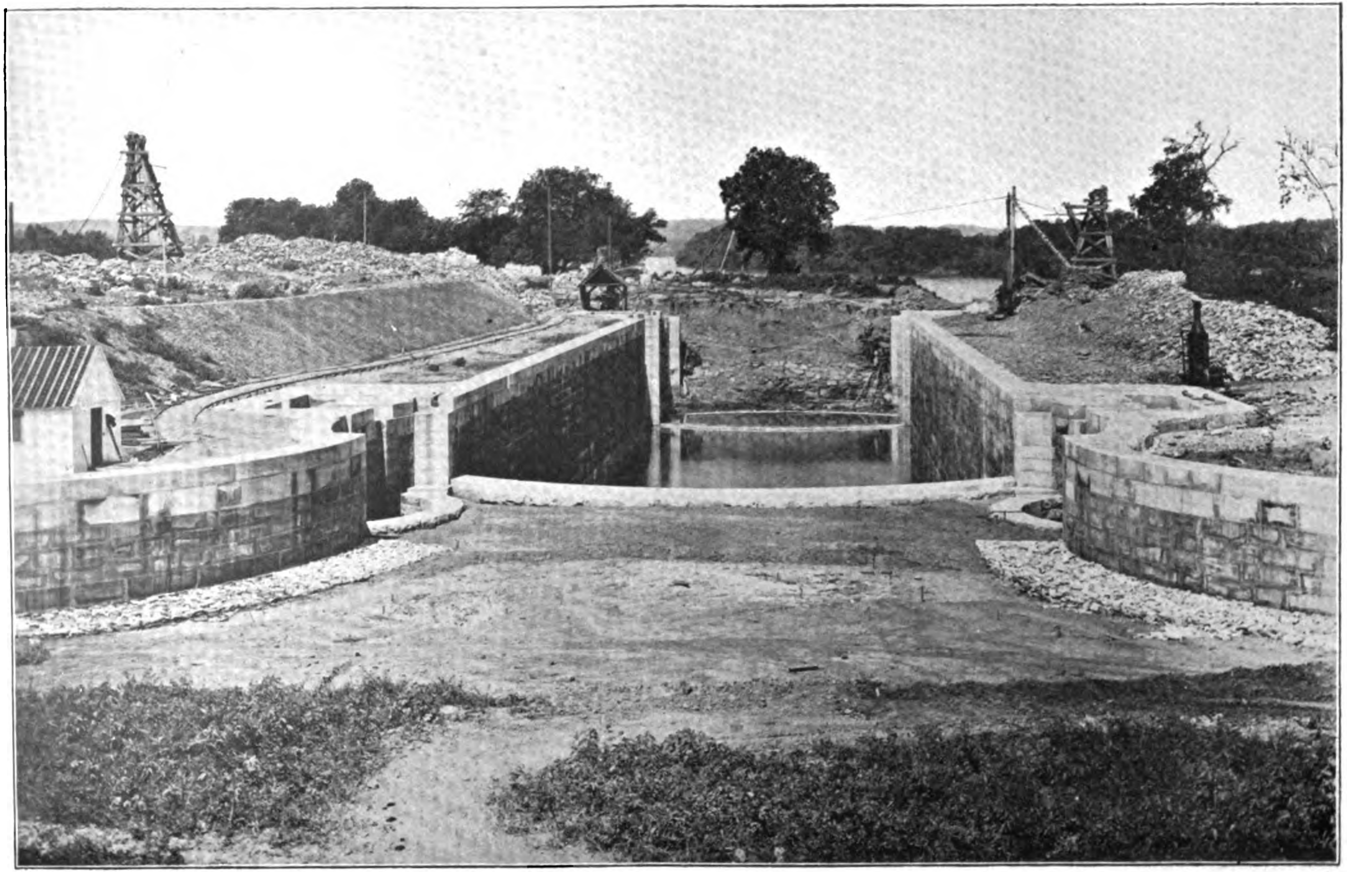
The granite for the quoins was purchased from the Southern Granite Company from their quarries at Lithonia, Ga. The cost of this stone, all cut, ready to set, was $41.55 a cubic yard.

The plant used at the quarry and at the lock was necessarily expensive, and though it is not entirely used up and destroyed, nevertheless its value has been considerably diminished. Before it can be used elsewhere it will have to be extensively repaired, and the cost of moving it to a new place must be charged against it. The amount expended for purchase and maintenance of plant has been about $56,000. The present useful value can not be estimated at over $25,000, and the difference must be charged to the cost of construction. Generally speaking, the plant was well designed for the work and has proved satisfactory and economical in its operation. Some of the machinery, notably the traveling crane, was originally too light for the strain imposed upon it. This has involved a good many breakages and considerable cost for repair and maintenance.

The cost of excavating the lock pit has been heavy, being nearly $93,000 in all. This is due in part to the unfortunate method in which it was done. About all that was accomplished by the contractor was excavation, and this he did not complete. He was paid for about 70,000 cubic yards of earth at 52 cents a cubic yard. Most of this was the upper portion of the excavation, the easiest to do, and which could have been done for much less than the contract price. In point of fact, the greater part of it was subcontracted for about 16 cents a cubic yard. The contractor undertook to retain the slopes by piles and sheeting, and undoubtedly expended a good deal of money in this way. Since the piles could have no foothold in the rock and since the excavation was to be carried down several feet into the rock, the revetment was a total failure. The revetment gave way by bulging and sliding out at the bottom, which added greatly to the cost of the subsequent excavation. The lack of room also necessitated a good deal of rehandling, and as a result 76,000 yards had to be moved to make an actual final excavation of 30,000 cubic yards. I think if the United States had done the entire excavation from the start, a saving of something like 40 per cent would have been effected.

A very full and careful record has been kept of all the field cost of constructing the lock at Riverton, and a study of the tables is very interesting. These show that the unit price of earth excavation for over 100,000 cubic yards of earth was 58¼ cents; that for rock excavation of 16,000 cubic yards the cost was $1.70; that for 3,452 cubic yards of fine-pointed masonry in place the cost was $15.26 a cubic yard; that for about 800 cubic yards of rough-pointed masonry the cost was $14.44

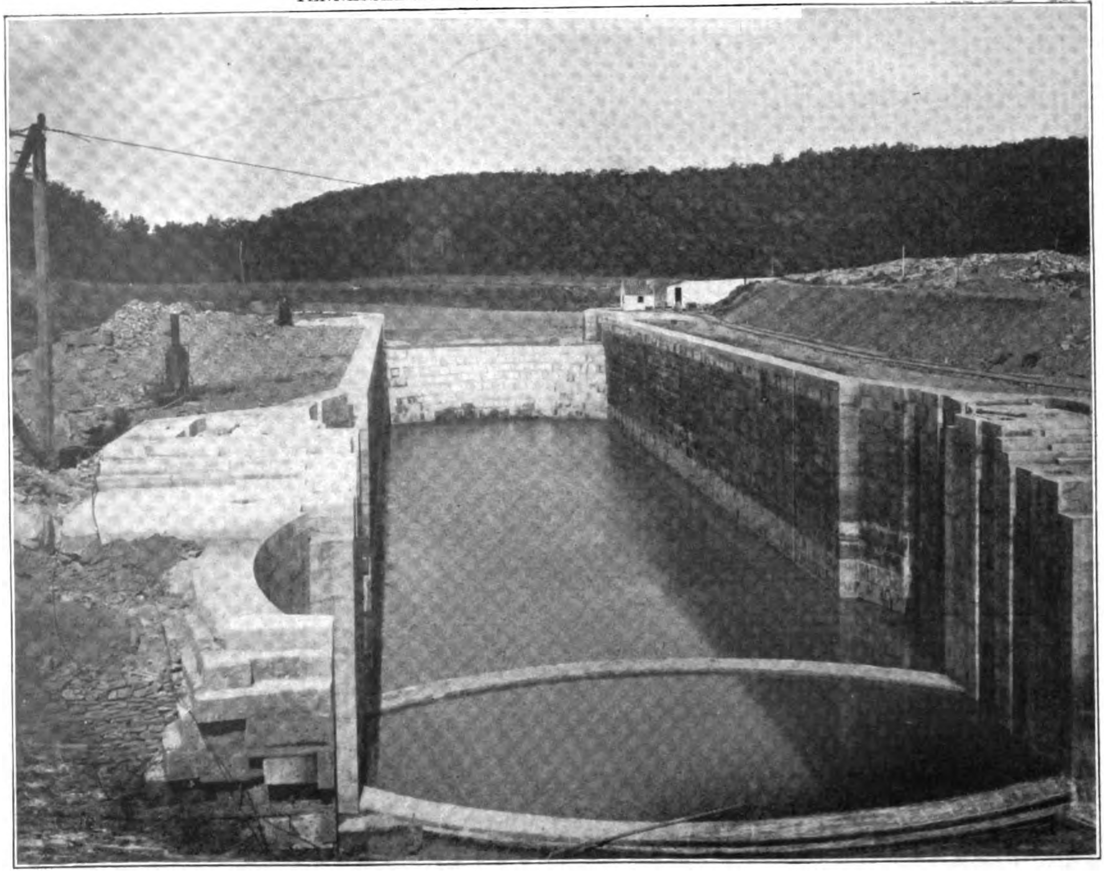
TENNESSEE RIVER, COLBERT SHOALS, JUNE 30, 1897.



GENERAL VIEW OF LIFT LOCK AT RIVERTON, ALABAMA. LOOKING DOWN—WEST.

ALABAMA, LOOKING DOWN WEST

TENNESSEE RIVER. COLBERT SHOALS. JUNE 30, 1897.



GENERAL VIEW OF LIFT LOCK AT RIVERTON, ALABAMA. LOOKING UP—EAST.

a cubic yard; that for about 100 yards of rock-face masonry the cost was $13.97 a cubic yard; that for coping it was $25.48 a cubic yard; that for about 500 cubic yards of cut-stone arch masonry the cost was $26 a yard; that granite quoins cost $44.25 a cubic yard; that rubble backing cost $8.21 a cubic yard; that concrete cost $8.42 a cubic yard, and that the average price of 26,359 cubic yards of masonry of all kinds was $10.73.

The original estimated cost of the lock was $399,324, and its actual cost, deducting the present useful value of plant and material on hand, was $412,000, which, considering the manner in which the work was done, first by a failing contractor and finally by day work, is, I think, unusually close.

THE ENTRANCE TO THE LIFT LOCK.

Much study has been given by the assistant in local charge of construction and by myself to the subject of a suitable entrance to the Riverton Lock, and much assistance and many valuable suggestions were received from Colonel Barlow, the division engineer. A project was finally prepared and submitted to the Chief of Engineers on April 28, 1897. The project was not approved, and a Board of Officers was appointed to report upon it. The report of the Board is printed herewith, page 2292.

This report was approved by the Chief of Engineers June 28, 1897. A drawing* showing the plan proposed is transmitted herewith, and two photographs taken at the end of the fiscal year, which show as well as can be shown in photographs the present condition of the lock.

The portion of the river upon which the lock and the proposed canal are situated was visited during March, 1897, by a flood which exceeded all previous records. The flood was extraordinary in that it was purely local. The river at Chattanooga and even as far down as Decatur was not excessively high, but the rainfall in the vicinity of Florence and Riverton was certainly abnormal. During ten days the rainfall in this vicinity exceed 13 inches, and this was discharged into the river when at an ordinary flood stage. As a result the river on Colbert Shoals attained a height greater than ever before known, being 2½ feet higher at Riverton than any previous record and 2 feet at the site of the proposed guard lock.

This flood, which of course may be equaled in the future, will necessitate a revision of the plans for the upper lock and for the embankment and wall of the canal. Plans for the guard lock are practically completed, but they will be withheld until they can be thoroughly revised. The flood of course entirely submerged the lift lock. Its approach was foreseen sufficiently early to permit the lock to be filled gradually in such a way as to prevent a large amount of earth from being washed into it. It was allowed to remain full until after the flood subsided, when it was slowly pumped out so as to prevent an extraordinary strain from being thrown upon the walls, due to this first saturation of the back fill, and also to prevent excessive sliding of the earth which was not supported at the ends of the lock. No injury resulted to the lock from the flood, though some loss occurred from the destruction of storehouses, of the water tank, and from the overthrow of some of the derricks.

This tremendous rainfall, amounting to as much as 3 inches an hour on one or two occasions, shows that careful study will be necessary to devise proper plans for taking care of the water which must necessarily flow into the canal. The watershed has been surveyed and it is found that a total drainage area of 9,500 acres must be considered. The run-off from this area during continued and excessive rains like that of March, 1897, will be practically equal to the total hourly rainfall. This shows that for short periods of an hour or two as much as 3,000 cubic feet a second must be taken care of at times when the reservoir formed by the canal itself has been completely filled by previous heavy rain. Overflow openings equal in area to a space 80 by 6 feet must therefore be provided. Ordinary spillways will not be available, because the surface of the canal is very much below that of high water in the river and the continuous levee necessarily prevents the use of them. Plans are being considered for a suitable spillway just above the lift lock, where the canal crosses a small creek. It seems at present best to carry the canal over the creek on one or more masonry arches and to provide suitable sluice gates at this place to regulate the water surface and to discharge the excess. A very considerable amount of water can be discharged through the culverts of the lock, but of course nothing like 3,000 cubic feet per second. Plans, however, for taking care of this water will be completed and submitted before it will be necessary to commence the construction of the main trunk of the canal.

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*Not printed.

Attention is specially invited to the very thorough and complete report of Assistant Engineer Nelles, which is transmitted herewith. This report contains many valuable and useful tables, giving cost and quantity, with reference to lock construction.

I think that it will be valuable in preparing estimates for other works of this kind.

TENNESSEE RIVER BELOW RIVERTON, ALA.

This section of the river, 226 miles in length, is below most of the large tributaries. For this reason it carries at all times the greatest amount of water found in the river, and as the width in general is not excessive and the slope quite uniform and moderate the best navigation is found here. Indeed, for several months out of the year during the high water-season, this portion of the river is navigable by the largest classes of steamboats found on the Ohio and Mississippi rivers. During the low-water season, though no insurmountable obstacles exist, navigation is possible only by very light-draft boats. For this reason less attention has been paid in the past to the improvement of this portion of the river than has been given to the portions above. Perhaps less attention has been paid to it than the value and importance of its commerce required, for not less than three-fifths of the entire business on the river and its tributaries is annually done upon this section of 226 miles.

For a great many years the only map that existed of this part of the river was the result of a reconnaissance made by a United States Coast Survey party in 1864–65, which map was prepared for military purposes. This map, while remarkably correct and accurate considering the method of preparing it, was nevertheless not sufficiently in detail to be used as a basis for plans for permanent improvement.

The act of Congress of August 17, 1894, authorized a survey of this portion of the river to be made. Of course the work could only be done during the periods of low water. In November, 1894, a party was in the field under the direction of Lieut. James F. McIndoe, Corps of Engineers. This party covered about 38 miles of river. In August, 1895, another party was placed in the field under the direction of

Assistant Engineer F. B. Williams. This party continued the survey down to Fort Henry, about 60 miles above Paducah, Ky. In September, 1896, the same party again took the field and completed the survey down to the mouth of the river.

The work of plotting the notes was carried on in the office while the party was not in the field, and a set of charts was completed in April of the present year. The work was plotted on sheets of heavy paper 2 by 3 feet, the scale being 1 inch = 500 feet, and a continuous map is obtainable by joining these charts. It required 63 such charts to exhibit the entire 226½ miles of river from Riverton, Ala, to Paducah, Ky. A report of the field and office work connected with the survey, which has been prepared by Assistant Engineer Williams, is transmitted herewith. Copies of the charts are now being made to accompany the final report on the survey to the Chief of Engineers.

I am not prepared at this time to submit a complete project for the improvement of this portion of the river, but a preliminary study of the notes and charts, combined with a personal reconnaissance, indicates that the improvements will not be difficult or very expensive, and that most of the obstructions to navigation can be advantageously removed by dredging.

During the past year I had an excellent opportunity to test the nature and extent of these obstructions in a very practical manner. A very large amount of sand was needed at Riverton, Ala., for the construction of the lift lock at that place. Some sand had been obtained by rail from Memphis, Tenn., but the railroad rates were excessive, and this method of obtaining sand did not prove satisfactory. For this reason I made use of the towboat and barges belonging to the United States to bring sand from Paducah to Riverton. This work was done during extreme low water, and six trips of the towboat were made. Upstream tows of this kind at low water fully develop the nature and extent of the obstructions. The master of the towboat was a pilot of long experience on that portion of the river, and by my direction he made a list of the location, nature, and extent of all the obstructions that he encountered. I made a trip with him on the towboat and personally verified the accuracy of his report. I think that his report is of sufficient interest to give it here. It is as follows:

LIST OF OBSTRUCTIONS BELOW RIVERTON, ALA., ON THE TENNESSEE RIVER; THEIR NATURE AND DISTANCE APART; PREPARED BY CAPT. LOUIS D. PELL, MASTER U. S. STEAMER LOOKOUT.

No. 1.—Riverton Harbor and Landing: River about 1,000 feet wide; flat and shallow. Gravel bottom, several gravel bowlders or lumps; very much in the way; very easily removed. Depth of water about 30 inches in channel left-hand side of river.

No. 2.—Eastport (Miss.) Landing: One mile below Riverton. Channel left side river; good water. Several snags and logs in river near landing; can be easily removed.

No. 3.—Bear Creek Shoals: One mile below Eastport. Channel right side of river; very shoal and swift. Gravel reef about 500 feet; easily dredged. Zero mark at Johnsonville, Tenn., makes 26 inches water over these shoals.

No. 4.—Channel left-hand shore above and below mouth of creek (Indian): Three feet depth at zero. Gravel bottom, with several bowlders and logs, covering a distance of 6 miles to head of Line Island.

No. 5.—Head of Line Island, Alabama: Channel right side of river; good water at low stage. Several gravel lumps on right side of channel near head of island. Will be easy to dredge.

No. 6.—Mouth of Yellow Creek: One and one-half miles below Line Island. Channel left side of river; good depth of water. Gravel bottom. Several logs near channel to remove.

No. 7.—Two miles below Yellow Creek: Near middle of river in deep water close to channel, one large gravel lump; can be easily removed.

No. 8. Good water for the next 4 miles to Duncans Landing. On right bank there are several gravel lumps, very much in the way; can be easily dredged.

No. 9.—About 6 miles good river to head Big Bend Shoals. At mouth Chambers Creek, on left bank, there are several rock and gravel reefs on right and several logs and rock heaps on left side of channel. Very flat and swift. Crooked, with a depth of 26 inches with Johnsonville gauge at zero mark. Dredging and snagging will be very beneficial here.

No. 10.—Hamburg, Tenn., 1½ miles below foot of Big Bend Shoals: Channel left side. Part of steamboat wreck lower end of landing.

No. 11.—Very good river to head of Diamond Island, 6 miles below Hamburg. Channel left side of island; smooth gravel bottom; 3 feet in channel when gauge at Johnsonville is at zero. In channel at head of island: Two sunken logs, easy to remove. As you enter chute, wreck of *Rapidan* is in the way. Several snags and logs, also several bunches of gravel lumps, very much in the way; all easy to remove. Good river to head of Wolff Island.

No. 12.—Head of Wolff Island, 5 miles below Pittsburg Landing: Channel used by steamboats down left side of island. At Crumps Landing, head of chute, water deep, but very narrow and swift. There is a gravel spur at landing which should be removed. Three hundred yards below Crumps Landing is a very shallow gravel reef; 30 inches on same when river is at zero. Halfway down island there are two gravel spurs extending out into channel which are very dangerous. Near foot of island, one bunch of gravel rock, very much in the way. All easily removed.

No. 13.—In right hand bend, 2 miles below foot of Wolff Island, there is a rock reef extending about 300 feet out into the river; at low water it is nearly dry. Right shore has more water and would make a better channel if cleaned out.

No. 14.—Good river for the next 6 miles to foot of Chalk Bluff; here there is a ledge or spur of gravel rock extending out into the river from left shore 200 yards. About 1 foot water on same in low water. Very much in the way and dangerous; can be easily removed. Good river for the next 9 miles, with exception of two snags in channel.

No. 15.—Petticoat Ripple, 9 miles below Chalk Bluff: Channel on right shore; gravel bottom; swift and very shoal; 3½ feet at low stage. Several logs in the way on right shore. Gravel lump at foot of bar.

No. 16.—Swallow Bluff Island, 4 miles below Petticoat Ripple: Channel down left chute. Gravel bottom. Halfway down chute is a gravel rock point which should be removed. At head of chute leaning timber should be cut away.

No. 17.—Head of Eagle Nest Island, 5 miles below: Channel on left shore; 3¼ feet when at mean low-water mark. Current swift; gravel bottom. Should remove logs and snags at head and foot of island.

No. 18.—Roaches Bar, 3½ miles below foot of island: Channel right side, close to shore. Timber and two sunken logs in the way. Depth of channel at low water, 4 feet.

No. 19.—Head of Beach Creek Island, 5 miles below Roaches Bar: Channel sets across head of island, then down left side; very crooked and swift. A sunken barge, caught on a bunch of gravel rock in center of channel between the two bars at head of island, is very much in the way. A large rock at foot of bluff on right-hand shore should be removed; very dangerous to towboats and packet steamers. Several snags and breaks to left of island should be removed. Leaning timber below Government light, left shore, should be cut away and the bank cleared of stumps and rocks, as steamers are often carried against this bank by the set or draw of water, which is very hard here.

No. 20.—Buffalo Shoals, 1 mile below Beach Creek Island: Channel left side, close to shore. A gravel rock reef runs very close in to left-hand shore, making channel very close and narrow; end of reef should be taken off. Shore above and below reef should be cleared of snags, logs, etc.

No. 21.—Double Islands, 2½ miles below Buffalo Shoals: Channel down right side; good water, except about 300 feet close to right shore at foot of island. Leaning timber at head and several logs and snags should be removed; 3½ feet at low water.

No. 22.—Armstrongs Towhead, 3½ miles below Double Islands: Channel right side, swift and flat. Several bunches of gravel rock close to right side of channel should be removed.

No. 23.—Mouth of Cedar Creek, 2 miles below Armstrongs: Channel right side; gravel bottom. Channel depth, 3½ feet at low-water stage. Several logs right side of channel, also several logs and snags in Cedar Creek Landing to be removed.

No. 24.—Webbs Landing, right side of river, 4 miles below Cedar Creek: Gravel bar formed in lower edge of landing. Bar about 400 feet long; gets dry when there is 5 feet in channel; should be dredged; very troublesome to steamers.

No. 25.—Beach River Bar, 1½ miles below Webbs: Flat gravel bottom, about 600 feet wide; 3½-foot depth at low stage of water.

No. 26.—Perryville, Tenn., reach: Very good water to head of Densons Island.

Two snags in channel just below landing at Perryville. At Elk Landing, a short distance from Perryville, there are a few rocks just under water, which have sunk one and injured several steamers; they should be removed.

No. 27.—Densons Island, 1 mile below Elk: Channel right chute, very swift and narrow. Channel runs close in to shore and at head of chute current sets in hard on shore, making it very dangerous, as the right shore is lined with fallen trees and stumps. The bank should be protected in some manner, as it is cutting very fast. Chute should be cleared from head to foot.

No. 28.—Good river for 14 miles to mouth of Duck River: Channel left side; good water. At head of bluff opposite mouth of river there is a gravel spur; end should be dredged off.

No. 29.—Head of Rockport Island, 2 miles below mouth of Duck River: Channel right side; smooth, gravel, and straight; 3½ feet depth at low water.

No. 30.—Foot of Rockport Island, opposite Rockport Landing: Channel right side of river; gravel bottom, very shallow and swift; about 300 feet over reef; can be easily dredged. This bar is the shoalest water below Big Bend Shoals.

No. 31.—Duck River Sucks, foot of bluff, 1½ miles below Rockport: Good water left side of river, but very crooked and narrow. At foot of bluff there is a rock spur extending out for some 200 feet, making channel so crooked as to be very dangerous for boats. Spur should be dredged from left shore to outside edge of same; along the bluff, above the sucks, the leaning timber should be cut and all logs and snags removed.

No. 32.—Thompsons Point, 500 yards below Sucks: There is a gravel rock reef extending 100 yards out into the river from left shore; should be dredged.

No. 33.—One mile below Thompsons Point: In middle of channel there is a bold break which I think is a concrete gravel lump; it can be hit in low water.

No. 34.—Very good water for the next 5 miles, to Johnsonville, Tenn.

No. 35.—Johnsonville, Tenn.: There is an obstruction in center of outside span of draw—think it is rocks left there while repairing the bridge some two years ago. Johnsonville Harbor is very shoal; difficult for steamboats to get in and out at landing in low water. I think by dredging a channel down the right shore below Elevator, past the point of Creek Bar, would make good water and a permanent channel.

No. 36.—Head of Reynoldsburg Island, 3 miles below Johnsonville, Tenn.: Channel on left side; swift water, gravel bottom; 4-foot stage at low water. At foot of left-hand bend there is a rock point which extends out into the river about 100 feet; very much in the way; has caused a great deal of damage to tows. Deep water above and below this point.

No 37.—One mile below foot of Reynoldsburg Island: In middle of river is a pile of gravel; easy to remove.

No. 38.—Green Bottom Bar, 2 miles below foot of Reynoldsburg: Channel on right side of river; very narrow and swift. Timber on shore should be cut away, and channel for a distance of about 100 feet at foot of bar should be dredged; several logs that should be removed.

No 39.—Turkey Island, 4 miles below Green Bottom: Channel down right chute; channel crooked and narrow; chute full of gravel rocks. All rocks on left of channel should be removed. Channel depth in chute, 5 feet at low water.

No. 40.—Head of White Oak Island, 1½ miles below Turkey Island: Channel left chute; gravel bottom; narrow and swift. A gravel lump at head of chute on left is very much in the way; should be dredged. The timber and logs below the Government light should be cleared away.

No. 41.—Hurricane Islands, 6 miles below White Oak: Channel down right side; good water; narrow; gravel rocks left of channel in middle of chute; can be easily dredged.

No. 42.—Leatherwood Shoals, 2 miles below Hurricane: Channel starts down left shore to Government light, then crosses under bar to right-hand shore; about middle of crossing there is a gravel reef about 100 feet wide which causes boats a great deal of trouble; it can be easily dredged; 3 feet at low water.

No. 43.—Head of Sandy Island, 2 miles below Leatherwood: Channel is on right side, with a depth of 4 feet; very crooked and swift; gravel bottom. On right shore there are several logs and snags; one pile of gravel rock to left and three or four piles of gravel lumps to right of channel at head of chute should be removed; also one narrow gravel reef on right shore, about halfway down chute, should be dredged; channel depth, 4 feet at low water.

No. 44.—Mouth of Sandy Landing, 3 miles below Sandy Island: Landing on left shore. It should be dredged and all logs removed.

No. 45.—Panther Creek Island, 8 miles below mouth of Sandy: Channel right-hand chute. Depth, 3 feet at low water. Very narrow, shallow, and swift; should be dredged. At head and foot of bar right-hand shore cleared of logs and stumps.

No. 46.—McCullochs Bar, 3 miles below Panther Creek Island: Channel at head of bar starts from Government light on right shore, crosses reefs diagonally to left shore, going in at the head. The reef should be dredged. There is a wreck of an old barge at head of bar, opposite Government light, which should be removed. At foot of bar, to the right of channel, there are some gravel bowlders which should be dredged; 3½ feet at low stage of water.

No. 47.—Blood River Island, 3½ miles below McCullocks Bar: Channel right side of island; good water; gravel bottom. Chute has several gravel lumps in it that should be removed.

No. 48.—Newburg Landing, Kentucky, 3 miles below Blood River Island: Left shore, this landing is very flat; should be dredged to a 3½-foot stage at low water.

No. 49.—Highland, Ky., 4½ miles below Newburg, Ky.: A very bad place in low water. Channel down left shore; very close and swift. Two gravel lumps on right of channel and logs down the shore on left side make this a dangerous place. Can be easily dredged; channel depth, 4 feet at low water.

No. 50.—Penticost Towhead, one-half mile below Highland: Channel now leaves left-hand shore and goes out past the foot of towhead, then back to left-hand shore. There is good depth of water down left-hand shore. I think channel should and could be made go down left shore. There are several gravel lumps to remove to accomplish this.

No. 51.—Widow Reynolds Bar, 5 miles below Penticost Towhead: Channel right side; smooth gravel bottom; shoal for one-half mile; depth of channel, 3½ feet at low water. One large log to left of channel to be removed.

No. 52.—To the right of channel, about one-half mile below Reynolds Bar, there is an old wreck of a steamboat; very much in the way; should be removed. Ironton Landing, just opposite the wreck, should be dredged out to 3½-foot depth at low water.

No. 53.—Grubb Towhead, 7 miles below Reynolds Bar: Channel should be dredged lightly down left shore for a distance of 800 feet to a false point, just above Government light. At this point there is a gravel rock spur extending out from left shore about 75 feet, and just opposite is a wreck of a barge. Steamboats have to go between them, and it is a very narrow channel; the wreck should be removed and the rock point cut away. Just below Government light, down left shore, is a reef of rocks extending to edge of channel which should be removed.

No. 54.—Birmingham, Ky., on left shore at foot of Grubbs Towhead: Could be made a good landing, as it is gravel bottom and would be easy to dredge.

No. 55.—Head of Twenty-Seven Mile Island, 4 miles below Birmingham, Ky.: Channel is on left side of island, very shallow, swift, and full of gravel lumps. This place has been the cause of much delay and expense to steamers. All lumps should be dredged out, timber cut, and logs removed down left-hand shore 1,000 feet above and below the Government light; then, perhaps, it would become a good channel.

No. 56.—Foot Three-Mile Island: There is a narrow gravel reef about 100 feet wide; gets very shallow in middle of river. Should be dredged to a 3½-foot depth at low water.

No. 57.—Foot of Twenty-Seven Mile Island: Channel is on left shore, swift and shallow; gravel bottom, with gravel ock spurs extending out from left shore; channel depth at low water, 3 feet.

No. 58.—The timber, logs, stumps, etc., on the left shore above and below the C. O. & S. W. R. R. Bridge should be cleared off for a distance of 600 feet each way.

No. 59.—In middle of river one-half mile below railroad bridge is the wreck of a coal barge which should be taken out and the lumps formed by it dredged out; channel depth down middle, 3½ feet at low water.

No. 60.—Head of Little Chain, 6 miles below bridge: Channel down left shore, gravel bottom. There are two sunken coal boats at head of bar which should be removed and gravel lumps formed dredged away.

No. 61.—Foot of Little Chain: Left shore should be cleared of timber and logs, also several large gravel bowlders to right of channel taken out. On left-hand point there is a gravel spur which should be dredged off.

No. 62.—One mile below Little Chain: In the middle of the river opposite the mouth of Guess Creek there are several gravel lumps which should be dredged.

No. 63.—Big Chain: Channel down middle of river through gap in rocks. There are two rocks on the left-hand side that should be taken out.

No. 64.—Lower Crossing Big Chain: This place has caused a great deal of trouble and expense by steamers and rafts running aground on lower left-hand bar. I would suggest that a spur dam be run from left-hand shore 300 yards below Government light out into the river 200 yards. I think this would keep the water from drawing down onto left or lower bar.

No. 65.—Head of Tennessee Island, 14 miles below Big Chain, mouth of Tennessee River: Channel crosses above head of island. Several breaks here which I think are logs and gravel rock; light dredging is needed here. Channel depth at low water is 3½ feet.

No. 66.—Paducah, Ky., Harbor: Good water from wharf to city limits. Several breaks which are parts of sunken rafts and wrecks.

It is seen that he notes sixty-six different obstructions. Their location is certainly accurate and their extent and character are doubtless generally so. His remarks as to the manner and ease of removing these obstructions are perhaps not altogether correct, as these are matters with which he is not expected to be familiar, but it is sufficiently evident that snagging, removing of wrecks, and dredging will be the principal methods adopted in improving this portion of the river. The United States has no dredging plant suitable for this work. A very powerful dipper dredge, capable of handling cemented gravel and other hard material, is needed, and it should be provided with suitable dump scows for the removal of the excavated material. Such a plant will cost not less than $30,000, and the funds on hand are not sufficient to justify its purchase. It is my intention, with the approval of the Chief of Engineers, to hire a dredging plant, if a suitable one can be found, and keep it at work sufficiently long to test the value and efficiency of dredging as a means of improvement.

REMOVAL OF SNAGS AND OTHER OBSTRUCTIONS.

Some snagging work was done during 1894 and 1895, a hired derrick boat and towboat being employed for this purpose. In 1896 a towboat was purchased for the United States and the construction of a snagging barge was commenced. This barge was designed after careful study of snag boats used in the Vicksburg district. It is a barge 100 feet long, 30 feet wide, and of 5 feet depth of hold. It has cabin accommodations for 17 men. It has a gallows frame equipped with a simple whip and double purchase and triple blocks. Its power is obtained by two No. E Providence steam capstans, having double 6 by 8 inch engines. Steam is supplied by a 35-horsepower return tubular boiler. The latter also supplies steam for a high-duty pump having a 14-inch steam and a 6-inch water cylinder and 12-inch stroke. The barge is provided with four spuds to hold it in position. This barge was not completed in time to be used during the low-water season of 1896. The delay was due to the slow delivery of materials required for its construction. It is now ready and thoroughly equipped, and is waiting at Riverton until the work hereafter to be described at Livingston Point is completed, which will be about the 6th of July. It will then be taken by the U. S. towboat *Lookout*, and during the entire low-water season will be employed in the removal of snags and wrecks.

Leaning and overhanging trees have always been very serious obstructions to navigation upon this portion of the river. To remove them a party of laborers under the direction of a foreman was taken upon a quarterboat in December, 1896, to work over the entire river for the removal of such obstructions. Nine thousand and thirteen leaning trees were cut and 199 trees were trimmed and 26 snags removed from the channel; thus clearing 87,762 linear feet of bank. This improvement affords great relief to navigation, particularly in the narrow chutes and in the vicinity of the regular landings.

The total amount expended on this portion of the river during the present fiscal year, including the cost of the survey and plant, was $25,239.17.

LIVINGSTON POINT, KENTUCKY.

Livingston Point is a narrow strip or tongue of land lying between the waters of the Ohio and Tennessee rivers, just above the mouth of the latter stream. This point and two small islands below it form the harbor of Paducah, and by their position prevent the ice-bearing current of the Ohio from entering the harbor, which is supplied with the warmer waters of the Tennessee, flowing from a southern latitude and rarely, if ever, troubled by ice.

The currents of the two streams are parallel for about a mile on either side of Livingston Point, and the Ohio River was rapidly encroaching upon this narrow barrier. The Tennessee River does but little damage. Near the extreme end of the point the Ohio had washed through at high water.

Allotments from the appropriations for improving Tennessee River below Chattanooga, to be used at Livingston Point, Kentucky, at the mouth of said river, have been made as follows:

Act of September 19, 1890	$25,000
Act of July 13, 1892	25,000
Act of August 17, 1894	25,000
Total	75,000

A survey of Livingston Point was made in December, 1890, and, based upon the data thus obtained, a project for its preservation, with an estimate of $180,000, was submitted January 12, 1891, to the Chief of Engineers, which was approved by the Secretary of War on the 16th of the same month.

As stated in the Report of the Chief of Engineers, 1891, page 2256—

> The plan of improvement adopted for preserving this point from destruction consists in covering the wearing slopes with a revetment of stone and brush, carried well down the bank below the water surface, supplemented by a pile and stone dike along the crest of the weakest portion of the line, where the current of the Ohio has already cut through at high stages of the river, the object of both works being to hold in its present position the land now existing, and to cause, if possible, a further deposit of sediment on the Tennessee side of the dike, which, from the present indications, is likely to occur.
>
> The revetment of stone and brush is specially needed on the Ohio side and will be but sparingly required on the Tennessee side. It will be carried well below low water, where it will consist of brush weighted down with stone, in alternate layers. From low water to foot of dike broken stone will be carefully placed.

The amount expended, including outstanding indebtedness, to the close of the fiscal year ending June 30, 1896, was $55,136.05, which has secured the completion of the dike on the Ohio side, across the "washout" near the extremity of the point, for a distance of 660 feet, and the protection of the bank for a length of 2,330 feet, extending 632 feet above the dike and 1,038 below it, the average width being 47 feet, all the work being done on the bank facing the Ohio River, so as to protect at once the low part of the exposed strip or "point," which was in danger of washing away. The work under contract for the shore protection of the Ohio bank of Livingston Point, by building a revetment of brush and stone riprap, was carried on in December, 1892, and from April to September, 1893, 9,092 cubic yards of stone, at $1.23 per cubic yard, and 274 cords of brush, at 94 cents per cord, being used, at an aggregate cost of $8,979.90. This contract was completed and terminated November 9, 1893, in accordance with its terms.

During an examination of Livingston Point, in July, 1893, it was found that unusually heavy ice and high water had greatly injured the point by causing the wearing away of the Tennessee bank to an alarming extent. It was recommended that the Tennessee bank be also suitably protected by stone riprap. This work was approved and authorized to be done by hire of service and purchase of materials in open market. During the months of August and September, 1893, and January, 1894, 9,116.48 cubic yards of stone was placed as riprap protection to the Tennessee bank, at a cost of $1.23 per cubic yard, $11,213.26.

In order to determine what further work was necessary for securing

Livingston Point, a survey was authorized by letter of the Chief of Engineers dated November 21, 1895.

A party was in the field, under Assistant Engineer D. W. Church, from December 9 to 19, 1895, and made a careful survey, covering 9½ miles on the Ohio River and 3 miles on the Tennessee. A comparison of the partial sections taken around Livingston Point with those taken in 1893 shows that no important change has taken place. The stone revetment which covers Livingston Point for a length of about 3,000 feet from its lower end was in fairly good condition and no trace could be found of the break reported in March, 1895. Some repairs are needed where the stone has been displaced in the revetment and where a pile is broken in the dike. The owner of Tennessee Island reported that the bank at the head of the island receded at the rate of 20 feet per year.

The revetment on the Ohio side of Livingston Point has been repaired and strengthened during the present fiscal year by the addition of 6,000 tons of riprap. The stone selected was a heavy limestone, and was purchased, delivered on United States barges, by circular letter in the usual manner. The U. S. towboat *Lookout* was used to tow the stone, and a party of laborers was employed at Livingston Point to unload and distribute it. It was found that during the recent high water a current had flowed across the point at two places in such a way as to form broad and shallow channels about 3 or 4 feet in depth, which if permitted to remain would doubtless materially increase and finally cut off the point. To prevent further injury, levees were constructed across these low places and given a height equal to that of the general crest of the point. These levees were protected by a pavement of stone. Four hundred linear feet of levee was thus constructed, and 6,500 square feet of paving was required to cover it. It is thought that the point is now in very good condition, but work of this kind demands constant waiting and frequent repairs.

The amount expended during the fiscal year at Livingston Point, including outstanding indebtedness, was $7,173.10.

THE U. S. STEAMER COLBERT.

The general towboat used in this district has been in commission during the entire year. It has run 5,080 miles and consumed 13,913 bushels of coal, or at the rate of 2¾ bushels per mile run. It has made 44 trips, towed 45 barges, assisted 1 steamer in distress, and has removed 2 snags from the channel. Its hull is at present in a very bad condition. It will be docked during the coming low-water season and the necessary repairs made.

APPROPRIATIONS.

March 2, 1827	$200.00
August 30, 1852	50,000.00
June 9, 1860	1,350.00
June 12, 1860	1,406.94
July 25, 1868	85,000.00
April 10, 1869	5,095.00
July 11, 1870	80,000.00
June 10, 1872	50,000.00
March 3, 1873	100,000.00
June 23, 1874	100,000.00
March 3, 1875	360,000.00
August 14, 1876	255,000.00
June 18, 1878	300,000.00
March 3, 1879	210,000.00
June 14, 1880	300,000.00
March 3, 1881	$250,000.00
August 2, 1882	250,000.00
August 7, 1882	3,970.18
July 5, 1884	350,000.00
August 5, 1886	262,500.00
August 11, 1888	250,000.00
September 19, 1890	475,000.00
March 17, 1891 (transfer settlement)	3.91
July 13, 1892	500,000.00
August 17, 1894	400,000.00
June 3, 1896	50,000.00
Total	4,689,526.03

Money statement.

July 1, 1896, balance unexpended		$473, 165. 23
June 30, 1897, amount expended during fiscal year		221, 853. 63
July 1, 1897, balance unexpended		251, 311. 60
July 1, 1897, outsanding liabilities	$14, 614. 03	
July 1, 1897, amount covered by uncompleted contracts	19, 500. 00	
		34, 114. 03
July 1, 1897, balance available		217, 197. 57
Amount (estimated) required for completion of existing project		5, 362, 939. 81
Amount that can be profitably expended in fiscal year ending June 30, 1899		2, 000, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for excavating entrance to lift lock at Colbert Shoals Canal, Alabama, received and opened June 16, 1897, by Capt. Dan C. Kingman, Corps of Engineers.

No.	Name and address of bidder.	Rate per cubic yard.	Total for 75,000 cubic yards.
		Cents.	
1	Wm. A. Kirk, Madison, Ind	50	$37, 500
2	I. V. Hoag, jr., Pittsburg, Pa	99	74, 250
3	T. B. Redmond & Co., Chattanooga, Tenn	45	33, 750
4	W. M. Buchanan, Riverton, Ala	38	28, 500
5	John B. Neely, Chattanooga, Tenn	26	a 19, 500
6	Fred H. Allison, Knoxville, Tenn	27	20, 250

a Lowest bid.

The bid of F. H. Allison was received by telegraph as follows:

"Unexpectedly absent yesterday. Upon my return to-day find your blanks. Forms being too late to mail bid, I hereby agree to furnish all plant and labor and do excavation for entrance lift lock, Colbert Shoals Canal, Alabama, at 27 cents per cubic yard, according to your specifications, and give surety or individual bond.

"FRED H. ALLISON."

Amount available, $150,000.

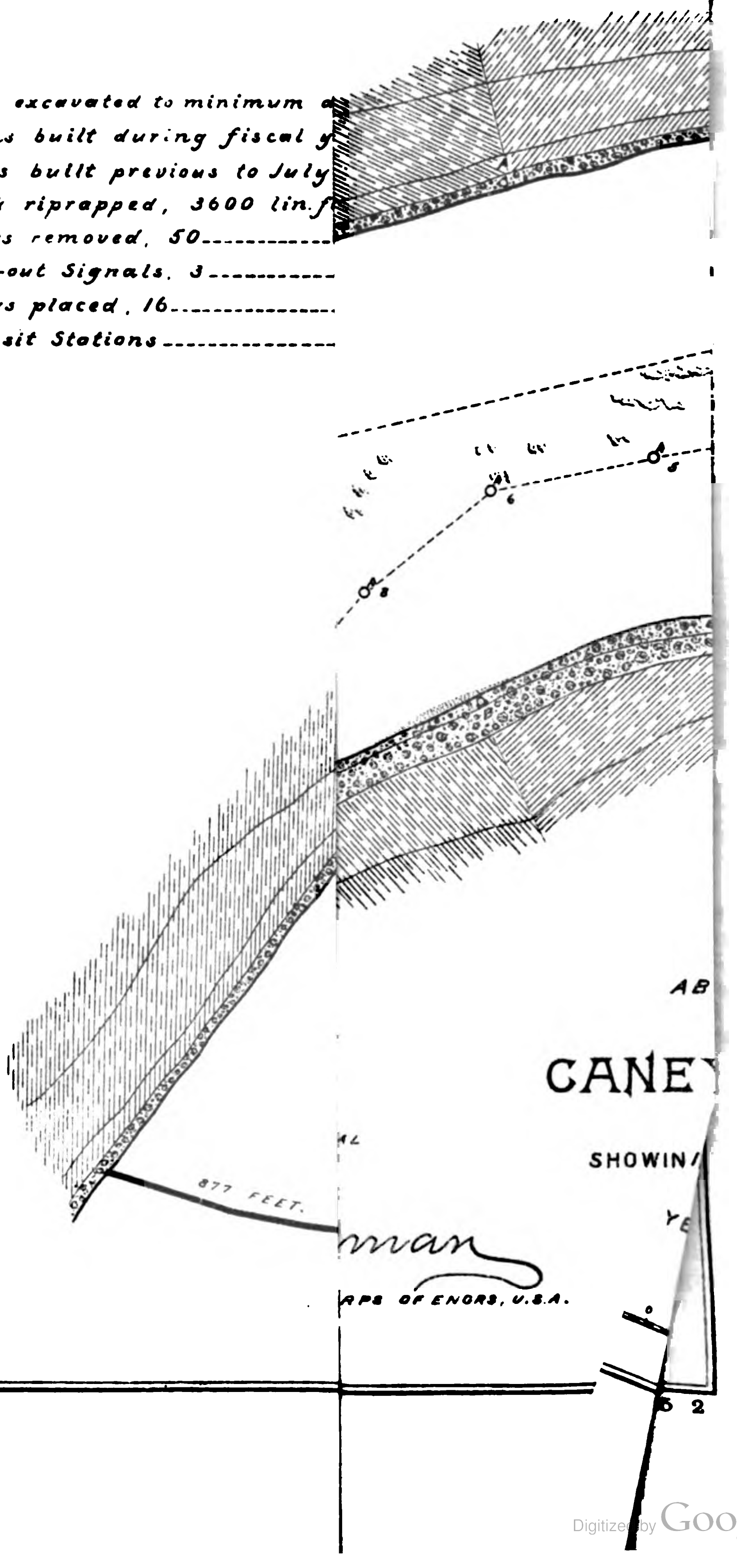
SURVEYS.

The mouth of the Tennessee River.—By direction of the Secretary of War and in compliance with the provisions of section 9 of the river and harbor act of June 3, 1896, a report was submitted for the mouth of the Tennessee River, Kentucky. No special survey was deemed necessary, because a survey had been made covering the ground in 1895, and the general survey of the river, which was completed in 1896, also included the mouth of the river.

A report was submitted to the Chief of Engineers dated March 20, 1897. No special improvement was considered necessary at this locality. This report was published in House Doc. No. 19, Fifty-fifth Congress, first session, and is printed herewith as Appendix B B 5.

SURVEY OF TENNESSEE RIVER AT CHATTANOOGA, TENN.

In January, 1897. the Chamber of Commerce of the city of Chattanooga, by its president, addressed a letter to the Chief of Engineers asking him to authorize a survey to be made of a portion of the water front of the city of Chattanooga, about 1,000 feet in length, which belonged to the city, and which it was thought might be improved for the public use. This communication was referred to me by the Chief of Engineers, and in reply it was stated that by utilizing a portion of the crew and the boats belonging to one of the United States towboats



Reefs excavated to minimum a
Dams built during fiscal y
Dams built previous to July
Bank riprapped, 3600 lin. f
Snags removed, 50
Turn-out Signals, 3
Buoys placed, 16
Transit Stations

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APS OF ENGRS, U.S.A.

when it happened to be in port, the survey could be made without appreciable cost to the United States. It was accordingly authorized; but it was not until the early part of June that a Government boat happened to be in port at a time when the stage of the river was sufficiently low to permit the survey to be made. It was then made by a detail from the officers and crew of the towboat *Colbert;* Assistant Engineer F. B. Williams did the instrumental work. A plat was prepared exhibiting the results of the survey and was transmitted to the president of the Chamber of Commerce on the 21st of June. It is believed that it contained the desired information.

The report of Assistant Engineer Williams relating to this survey is transmitted herewith.

REPORT OF MR. R. R. THACHER, ASSISTANT ENGINEER.

LENOIR CITY, TENN., *June 7, 1897.*

CAPTAIN: I have the honor to submit the following report on operations on the Tennessee River above Chattanooga, Tenn., for the fiscal year ending June 30, 1897:

At the close of the last fiscal year work was in progress at Caney Creek Shoals.

The force was employed in quarrying stone for dams and building two steam-derrick boats.

Channel excavation was resumed on September 3, 1896, with one No. 5 Rand steam drill, mounted on our drilling raft, and two steam-derrick boats. Work in channel suspended on November 29, 1896.

Much difficulty was encountered while drilling, owing to a deposit of sand left by the high water of the winter before. Frequent rises also retarded the work.

The excavation was begun at the new "Crossing," working on downstream to the "Rock-pile," removing reefs, logs, snags, and loose rock, attaining a channel 200 feet in width, with depth of 3 feet.

Distance worked over by channel party was 200 by 10,000 feet. Cubic yards excavated, 2,781. Buoys were placed at intervals along the channel, and white targets placed on the bank to indicate the channel and new "Crossing." Longitudinal Dam No. 3 was lengthened out 420 feet downstream and to the lower end was constructed a check dam 80 feet long.

The main reef at "Rock-pile" was padded with stone, making a low check dam 877 feet long to replace the water that had been taken from the channel by the removal of the reefs above.

The bar at the head of the shoals, composed of bowlders and gravel, was partly removed by the aid of the Lancaster grapple added to the plant last fall but received too late to be given a fair trial. Also 80 cubic yards was removed from Dam No. 1.

Work at Caney Creek Shoals was suspended on December 17, 1896, for the winter. Fleet was towed to Lock 6, Muscle Shoals Canal, by U. S. steamers *Long* and *Colbert,* where it remained during the winter undergoing the following repairs:

Steamer *Long:* Lengthened out 15 feet; model bow added; cabin put on upper deck; recalked and painted.

Two quarter boats: Hulls overhauled, calked, and painted.

Two quarter boats repainted.

Four stone barges: Hulls repaired, recalked, decked, and painted.

Two derrick boats recalked and painted, and other minor repairs.

The fleet was taken in tow on April 28, 1897, by the U. S. steamer *Colbert* and towed to Lenoir City, Tenn., there to await the arrival of the U. S. steamer *Long,* that is undergoing repair at Lock 6, Muscle Shoals Canal.

The following is the principal work done at Caney Creek Shoals during the fiscal year:

Stone quarried	cubic yards	3,225
Earth stripped (quarry)	do	800
Stone placed in dams	do	3,738
Stone placed in riprap	do	1,181
Loose rock excavated from channel	cubic yards	140
Solid rock excavated from channel	cubic yards	2,781
Old dam removed	cubic yards	85
Buoys placed along channel,	number	16
Targets placed on bank	number	3
Logs removed	do	50

Respectfully submitted.

R. R. THACHER, *Superintendent.*

Capt. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. W. S. WINN, ASSISTANT ENGINEER.

FLORENCE, ALA., *June 7, 1897.*

CAPTAIN: I have the honor to submit herewith a report of the work done under my supervision on the Tennessee River below Chattanooga for the eleven months ending May 31, 1897:

The plant in my charge consisted of the U. S. steamer *McPherson*, the *Harwood*, an Osgood dredge, 1¼-yard dipper, a 12-horsepower steam-derrick boat, 4 barges, and necessary skiffs and other appliances. Work was done at the following shoals: Bridgeport, Widows Bar, Head of Henrys Island, Beards Reef, Flint River Bar, Wagon Factory Bars, and Sweetwater Bar—given in their sequence coming down the river. In the estimates of the cost of materials removed there is included the cost of labor, material expended, subsistence, and the repairs incident to the work immediately in hand, other repairs being considered in the nature of a plant. As relates to the dredge, owing to the lightness of the machine for the heavy work undertaken, repairs formed a considerable part of the cost, both for material used and for the time of the crew in making the repairs. March and April and most of July and May were lost on account of high water, and during those times extensive repairs were made to the fleet. The following work was accomplished:

BRIDGEPORT.

Under the project for this place undertaken in 1893 work was in progress at the beginning of the fiscal year, but owing to an unprecedented high stage of the river, dredging was possible for only a few days of the first ten in July. The river still being too high at the last of that month, it was decided to take advantage of the favorable stage to take the dredging outfit to Beards Reef and leave the few remaining days of work at Bridgeport to be done by hand. A steam-derrick boat and a small force of men were employed here in October drilling and blasting and removing from the channel rocks that the dredge had been unable to handle.

The following work was accomplished:

Dredging 820 cubic yards of rock, clay, and gravel, at a cost of 41 cents per unit.

Excavation by blasting and removing with derrick boat, 285 cubic yards of rock, at $2.04 per unit.

When work was abandoned on account of the coldness of the water and a rise in the river, a channel 100 feet wide and 2½ feet deep at the shallowest places at low water had been finished from the bridge 1,400 feet upstream. The average depth of channel was much greater than this, it being 8 feet deep in many places whence large bowlders had been removed.

WIDOWS BAR.

This obstruction is about 5 miles below the bridge at Bridgeport. The entire shoal is about 3,000 feet long, but the principal obstruction occurs at the head where some ten or twelve reefs cross the channel and project 12 or 15 inches above the bed of the river. Here the channel affords only 8 inches at low water. It was considered that the excavation of a channel over the entire shoal would cost more than its importance with respect to the rest of the river would warrant, but that by the removal of the projecting reefs an increase of depth of a foot could be given at small cost. This latter project was approved early in October, and a force of men was immediately put to work. The reefs were closely drilled and blasted over a space 80 feet wide and 250 feet long, but, no derrick boat having been available for that work up to the time the November rise came, none of the rocks were removed. Work of removing the rocks will begin as soon as the river gets low enough.

HEAD OF HENRYS ISLAND.

The channel at this place in crossing the river passes between two large rocks on one side and one on the other; the channel being not more than 60 feet wide between them with a swift cross current. Situated as they are in the middle of the river these rocks, which reach up almost to the water surface at low stages, rendered the crossing a very dangerous one at night or when the wind prevented determining their exact location. The rocks were drilled and blasted and 6¼ cubic yards removed, giving an increase in depth of 15 inches over them. Cost, $23.72.

BEARDS REEF.

The project for this shoal was to cut a new channel down the left bank instead of attempting to improve the old channel, which made two abrupt bends in getting over the shoal. As many of the reefs as were exposed at the time were drilled and blasted in the fall of 1895, preparatory to removal with the dredge. Dredging was begun in the latter part of July of the present fiscal year, and continued till October. The reefs were of the hardest limestone and pure flint, and though blasted up as thoroughly as possible the cracked pieces were wedged together tight, and were hard to remove with the dredge, straining it in many cases to its fullest capacity. Rocks containing from 2 to 3 cubic yards were often removed, and one rock estimated to contain 5¼ cubic yards, weight 24,750 pounds, was swung around out of the channel. Others containing as much as 4¼ cubic yards were put on barges and dumped in deep water. The ledges were inclined upstream at an angle to the river bed of about 45 degrees. The heaviest ledges, 4½ feet thick, were frequently cracked sufficiently to be removed without drilling by simply exploding dynamite under them in the pockets dredged from above. Above the reefs for a distance of 40 feet the river bed was of shale, and below, sand and gravel.

Rock and gravel dredged, 9,385 cubic yards, at a cost of 20.9 cents per unit.

A steam derrick boat was used to clean up the ledges and bowlders the dredge would not handle, and accomplished the following work:

Rock removed with derrick, 190 cubic yards, at $1.44 per unit. Most of the rocks required to be blasted.

A channel 120 feet wide and 550 feet long was completed and thoroughly sounded to show a depth of 3 feet at low water. The method used for sounding was to attach a railroad rail to the ratchet chains and drop it over the bow of the steamboat to the required depth. Graduated iron rods were attached vertically to the rail to indicate when it was at the proper depth.

FLINT RIVER BAR.

By the time the dredge reached Flint River Bar the machinery was badly in need of repairs, and the work there was characterized by the number of break downs. The project was to dredge through the short bar along the right bank just below the mouth of Flint River. The old channel crossed from the mouth of Flint River to the left bank and back again in a distance of a quarter of a mile. The material dredged consisted of sand, gravel, bowlders, and ledges. The channel was left 3 feet deep at low water for a width of 60 feet, and 2 feet deep for an additional 60 feet of width. To complete the 3-foot channel for the 120-foot width will require drilling, blasting, and removal of reefs over a space 30 feet by 60 feet.

SWEETWATER BAR.

This bar at the mouth of Sweetwater Creek was formed by the loose rocks and gravel washing out of the creek. The creek is only about 3 miles long, and is subject to rises of 10 feet or more in a few hours. During low stages of the river the creek in its sudden rises rushes entirely across the slough of the river, often with sufficient force to cause landslides on Pattons Island, just opposite. At such times an eddy is formed below the mouth of the creek and this has been the means of depositing the bar there. The bar had encroached on the channel until it was very narrow and swift, and the current pitched toward Pattons Island. It was undertaken to straighten and decrease the current by widening the channel, and to prevent the re-forming of the bar by building a crib just opposite and 150 feet from the mouth of the creek, and a stone dam from the head of this crib to the bank just above the mouth of the creek. The object of the crib and dam was to direct the course of the current from the creek straight down the river bank. The crib was built of sycamore logs 1 foot in diameter and 50 feet long, and was filled with the dredged material and riprap. It was thought that in a few years it would grow up in willows and assuming the nature of a towhead, render the improvement permanent. The crib's dimensions are 4½ by 12 by 120 feet. Cost, $72.

Eight thousand five hundred and thirty-seven cubic yards of loose rock and gravel was dredged from the canal at a cost of 19.9 cents per unit. Two cuts of the dredge, 1,150 feet each in length, and one 520 feet, were made and resulted in straightening the current and decreasing its velocity as desired.

Three hundred cubic yards of rock was quarried at a cost of 31 cents per cubic yard.

WAGON FACTORY BARS.

These bars put out from the mouths of two wet weather branches, one above, the other below, the wagon factory at Florence, Ala. Though the channel was deep enough around the ends of these bars, they made the current very swift and crooked. The points were dredged off so as to give an additional width of channel of 60 feet, straighten and decrease the current. During May 2,099 cubic yards of sand and gravel was dredged from these bars, at a cost of 14.3 cents per unit. One half of the material was handled twice with the dredge, that method being considered cheapest, as there was no convenient dumping ground and not enough barges available at the beginning of the work.

The method of disposing of the dredged material at all the foregoing places was slow. It was placed on flat-topped barges and then shoveled off by laborers, the water in the vicinity of the shoals being too shallow to permit of dump scows being used.

The average cost per cubic yard for dredging was 23.6 cents, and the average cost of excavation by blasting and removing with derrick boat was $1.82.

AT FLORENCE, ALA.

Two cuts were made with the dredge just below the bridge and along the right bank, to facilitate the approach to the draw, 60 feet wide and 200 feet long, and requiring an average excavation of 3½ feet.

Three cuts were made in the channel about 400 feet below the bridge. The channel was thus widened 90 feet, and to a depth of 3 feet at extreme low water.

Total number of cubic yards dredged 2,084, at a cost of $268.95, or 12⅞ cents per cubic yard. Three-fourths of the material was either boated or handled with shovels in leveling off the cast-over material for a wharf.

From March 1 to June 1 extensive repairs were made to the entire fleet. The machinery and woodwork were overhauled, and all the boats and barges painted.

Respectfully submitted.

W. S. WINN, *Assistant Engineer.*

Capt. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORT OF MR. SYDNEY B. WILLIAMSON, ASSISTANT ENGINEER.

UNITED STATES MUSCLE SHOALS CANAL, ALABAMA,
June 30, 1897.

CAPTAIN: I have the honor to submit the following report of work done at Muscle Shoals Canal, under the appropriation for improving the Tennessee River during the fiscal year ending June 30, 1897.

A large proportion of this class of work has been repairs to the boats engaged in improving the river above and below Chattanooga, Tenn.

ABOVE CHATTANOOGA, TENN.

The fleet employed above Chattanooga was assembled at Muscle Shoals Canal in January, 1897, and a portion of the boats composing the fleet have been repaired as follows:

Steamer S. H. Long.—Repairing hull; lengthening hogchains; making bolts, stirrups, patterns for chucks and scuppers, studs, crank shaft, iron towing knees, bell pull, and valve stem. Drilling and bending stem band; overhauling and repairing machinery and pump, welding turn-buckles, drilling flanges, turning sheaves, and resetting boiler. Repairing and extending cabin, building new pilot house, painting hull and cabin throughout, and glazing cabin windows. Sawing and planing the necessary lumber.

Barges Nos. 1, 2, 3, and 4.—Repairing, painting, and calking hulls; redecking; sawing and planing the necessary lumber; making bolts, drilling and bending the stem and corner bands.

Three quarter boats.—Repairing hulls, calking and painting same; minor repairs to cabins and painting same throughout.

Two derrick boats.—Calking, painting, bracing with hogchains, and minor repairs.

Electric launch.—Repairing and painting hull; fitting up and setting engine.

BETWEEN CHATTANOOGA, TENN., AND DECATUR, ALA.

The boats engaged upon the improvement of the river between Chattanooga and Decatur have been repaired, as follows:

Steamer McPherson.—Making brackets for smokestack, patterns for brasses, eyebolts, key drifts, keys and wedges; molding and finishing brasses; drilling flanges for exhaust pipe; straightening wheel shaft, planing cam yokes, and generally overhauling machinery, boring cylinder for doctor, making cylinder rings, and planing valves. Building new wheel, stairway, and glazing sash, and painting cabin throughout. Sawing and planing necessary lumber.

Dredge Harwood.—Making bolts, valve stem, break lever collars and keys; repairing machinery, pump, shaft and bushing drum; making stirrups and strainer, and boring brass washers; drilling straps, plates, and steel pin. Repairing, calking, and painting hull. Sawing and planing the necessary lumber.

Barges Nos. 102, 103, 208, and derrick boat.—Repairing, calking, and painting hulls; making hog chains, drilling and bending stem bands and corner bands; sawing and planing the required lumber.

BETWEEN CHATTANOOGA, TENN., AND FLORENCE, ALA.

Nance Reef.—A longitudinal dam, about 500 feet in length, has been partly built on the south side of the chute at Nance Reef, the object being to deflect an objectionable cross current. The construction was abandoned because of high water, but will be continued when possible; 358 cubic yards of stone have been used, at a cost of $1.15 per cubic yard.

Little Muscle Shoals.—A similar current at the head of Little Muscle Shoals has been remedied by the construction of a wing dam containing 130 cubic yards of stone.

Burkette Island Levee.—One hundred and twenty-five cubic yards of riprap were used in revetting the slopes of a small levee on Burkette Island.

Dry dock.—A portion of the cost of constructing the dry dock has been charged to the appropriation for improving the Tennessee River below Chattanooga. The details have been given in the report of operation and care of the canal. A general view of the dock is shown by the accompanying photograph.

Snag boat.—A snag boat for use on the river below Riverton, Ala., has been built by hired labor. The general dimensions are: Length, 100 feet; width, 30 feet, and depth of hold, 5 feet; the draft is, approximately, 12 inches, and there are cabin accommodations for 17 men. The gallows frame is equipped with a simple "whip," a double purchase, and triple blocks. Power is obtained from two No. E steam capstans having double 6 by 8 inch engines, steam being supplied by a 35-horsepower return tubular boiler. The latter also supplies steam for a steam pump having a 14-inch steam and a 6-inch water cylinder and 12-inch stroke.

Miscellaneous.—Making gauges for Bridgeport, calking irons, saw "set," jackscrews for use in dry dock, bolts, nuts, etc., for repairing boats; repairing clamp screws; raising sunken barge at Patton Island; erecting shed for blacksmith at shipyard, grading and moving stone from shipyard, building skiff, repairing barges, sharpening and repairing tools.

A general view of the boats repaired during the year is shown on the accompanying photographs.

Very respectfully, your obedient servant,

SYDNEY B. WILLIAMSON,
Assistant Engineer.

Capt. DAN C. KINGMAN,
Corps of Engineers, U. S. A.

REPORTS OF MR. G. T. NELLES, ASSISTANT ENGINEER.

TENNESSEE RIVER IMPROVEMENT,
ENGINEER OFFICE, UNITED STATES ARMY,
Riverton, Ala., June 30, 1897.

CAPTAIN: I have the honor to submit the following report of operations in connection with the construction of the lift lock of the Colbert Shoals Canal, at Riverton, Ala., for the fiscal year ending June 30, 1897:

Under your order I assumed local charge of the work on October 5, 1896, relieving Mr. Sydney B. Williamson, under whose efficient management the plant had been installed and about 75 per cent of the work completed.

The annual report for the fiscal year ending June 30, 1896, gives a very detailed and full description of the lock, with dimensions and drawings, as well as the specifications under which the work has been done. The nature and characteristics of the materials and plant used and the general methods followed are also fully set forth. The general plans and specifications therein described have been conscientiously followed during the present year, and it is thought that the high standard adopted originally has been maintained throughout, and that the lock, which is now practically completed so far as the masonry work is concerned, will bear the most critical inspection and comparison with any similar structure.

In view of the fact that all of the work contemplated as a part of the lock construction, except the gates and valves, has been completed, I shall include in my review of the work of the year a general review of the whole work, with detailed statements of the total and unit costs of the various kinds of work.

The character and amount of work performed for each month during the year, and also the total liability incurred by this office, are shown in the following table:

TABLE A.—*Work performed during fiscal year 1897.*

[In cubic yards.]

Kind.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
Cherokee:													
Stripping	4,425	4,489	4,312	4,617	4,329	1,957	......	......	......	......	......	......	24,129
Quarrying	1,600	1,660	1,419	1,490	722	1,130	......	......	......	......	......	......	8,021
Scappling	1,488	1,435	1,098	1,406	500	......	......	......	......	......	......	......	5,927
Loading	1,444	1,413	1,495	1,663	904	1,600	......	......	......	......	......	......	8,519
Riverton:													
Earth excavation	5,100	5,180	2,800	1,300	2,000	......	1,200	2,520	......	......	200	120	20,220
Rock excavation	550	526	1,065	1,000	1,500	2,400	1,950	1,000	1,000	......	250	200	11,141
Rock fill, upper end	......	......	......	......	......	122	......	......	......	......	......	......	122
Back fill	5,650	5,706	3,865	2,300	3,500	......	......	......	......	......	500	......	21,521
Puddle	320	......	......	......	1,000	1,000	680	......	......	......	......	......	3,000
Stone cut:													
Fine pointed	188	131	102	57	90	17	......	......	......	......	......	......	585
Rough pointed	14	69	106	127	36	29	......	......	......	......	......	......	381
Rock face	20	30	24	......	......	......	......	......	......	......	......	......	74
Lift wall	......	......	......	25	......	117	250	14	......	20	26	......	452
Coping and sills	......	21	......	......	......	......	......	......	......	79	79	......	179
Coping	62	36	......	34	88	89	......	60	......	50	134	......	553
Arch	62	48	23	35	20	......	......	......	......	......	......	......	188
Backing	81	91	131	94	57	12	......	......	......	......	......	......	466
Grooves	135	95	105	267	......	......	......	......	......	......	......	......	602
Masonry laid:													
Fine pointed	469	306	131	350	160	131	......	......	......	......	......	......	1,547
Rough pointed	44	10	38	120	200	62	......	......	......	......	......	......	474
Rock face	20	30	30	......	......	......	......	......	......	......	......	......	80
Lift wall	......	5	63	......	......	......	......	......	......	......	417	......	485
Coping and sills	......	......	21	......	......	......	......	......	......	......	46	112	179
Coping	65	25	12	15	25	42	50	......	......	......	338	......	572
Arch	67	42	47	30	31	......	......	......	......	......	......	......	217
Quoins	......	9	10	60	25	37	......	......	......	......	......	......	131
Concrete	101	74	71	34	22	......	......	30	......	......	10	58	400
Rubble	1,507	1,160	1,461	1,870	1,860	742	......	......	......	......	30	......	8,630
Pointing, sq. ft.	......	1,800	106	1,650	......	......	......	......	......	2,000	324	1,000	6,880

The above statement may be briefly summarized as follows: 8,519 cubic yards stone quarried and shipped to Riverton; 31,661 cubic yards earth and rock excavation completed; 2,880 cubic yards stone cut and scappled; 12,715 cubic yards masonry laid.

Pay rolls for fiscal year 1897	$90,560.62
Other expenses for fiscal year 1897	43,513.57
Total liability, exclusive of Chattanooga office expenses	134,074.19

CHEROKEE QUARRY.

The failure of the top 30 to 40 feet of the quarry at Cherokee to produce any material suitable for use in the construction of the lock added greatly to the cost of operating the quarry, making it necessary to practically quarry and handle at least 3 yards of waste for each cubic yard of useful material. Much of the waste would have been valuable in a more thickly settled country for building purposes, and if the United States could have entered the market large quantities of it could have been disposed of as riprap and shipped to the Mississippi River—if not at a profit, at least for sufficient to have greatly reduced the cost of quarrying.

The quarries were opened in April, 1895. The first shipment was made in August, 1895, and the last in December, 1896. During this time a total of 19,572 cubic yards of stone was produced and shipped to Riverton. The quarries have since been shut down and entirely abandoned. The total detailed cost of operating them is given in the statement following.

TABLE B.—*Total cost of operating the United States quarry at Cherokee, Ala.*

Character of work.	Cost.	Total cost.	Per cubic yard.
Superintendence	....	$3,093.11	$0.15
Scappling 8,671 cubic yards, at $1.01½	....	8,812.47	....
Stripping 70,000 cubic yards, at 26 cents	....	19,261.85	1.00+
Quarrying 19,572 cubic yards	....	14,030.56	.72—
Royalty, 1,361 cars, at $1.20	....	1,633.20	.08+
Rent of land, 19½ months	....	191.66	.10+
Miscellaneous expenses:			
Supplies	$825.21	....	.04
Explosives	2,540.69	....	.13
Watchmen	353.70	....	.02
Storing, etc	1,087.93	....	.05+
Total	....	4,807.53	.24+
Loading for shipment:			
Labor	3,733.81	....	.19+
Coal, etc	535.91	....	.03—
Total	....	4,269.72	.22—
Plant:			
Miscellaneous—			
Labor	399.31	....	....
Materials	661.49	....	.05+
	1,060.80		
Railroad tracks—			
Labor	6,046.83	....	....
Materials	1,639.16	....	.39+
	7,685.99		
Derricks—			
Labor	1,018.38	....	....
Materials	991.86	....	.10+
	2,010.24		
Cableway—			
Labor	1,008.61	....	....
Materials	5,558.70	....	.34—
	6,567.31		
Tools	1,052.40	....	.05+
Total cost of plant complete	18,376.74	....	.93+
Present useful value of plant	5,500.00	....	....
Amount charged to quarry for plant	....	12,876.74	.66—
Freight charges, 1,479 cars	....	24,467.95	1.26+
Total cost of stone produced	....	95,169.79	....

RECAPITULATION.

10,901 cubic yards rough stone, delivered at Riverton	....	$48,099.57	$4.41½
8,671 cubic yards scapple backing, delivered at Riverton	....	47,070.22	5.43—
19,572 cubic yards sandstone produced, delivered at Riverton	....	95,169.79	4.86+
Present value of plant	....	5,500.00	....
Total cost of operating quarry	....	100,669.79	....

It will be noticed that the actual cost of quarrying is small, as compared with the cost of stripping, freights, and costs incidental to shipping and loading, being in the proportion of 1 to 2½, indicating clearly the points in which a saving can be effected in the Upper or Guard Lock if suitable quarries can be located on the river in its vicinity. Owing to the existence of the Colbert and Bee Tree Shoals it was not practicable to obtain stone for the Lift Lock from the river quarries. In the statement given above the cost of the plant used is shown, and in this case, and also throughout this report, the estimated present useful value of the plant has been credited to the particular class or classes of work for which it was used, charging only the cost of plant, with repairs and additions, less present useful value, to the work. Aside from the cost of production and delivery at Riverton the Cherokee stone was economical for the work, as the cost of cutting and working was low. However, it contains a large percentage of iron, and there is every indication that it will stain badly and detract greatly from the appearance of the walls. It is also very light in weight (135 pounds per cubic foot), which is 10 per cent less than many of the native limestones, and counts against the value of the stone for our purposes.

MATERIALS.

The total quantities and cost of the principal materials that have entered into the construction of the lock, whether purchased or produced, are shown in Table C, given below.

TABLE C.—*Cost and quantities of the principal materials used in the construction of the Lift Lock, Riverton, Ala., not including plant or materials used at the Cherokee quarry.*

Classification.	Quantities.	Cost.
Coal .... tons..	2,850	$5,398.48
Limestone:		
Fine pointed, cut .... cubic yards..	1,203	11,619.07
Rough pointed, cut .... do....	174	1,057.05
Rock face, cut .... do....	18	103.28
Scappled, cut .... do....	3,788	15,904.61
Rough	16	36.80
Coping, sawed one way .... cubic yards..	991	11,627.89
Sandstone:		
Rough .... do....	10,079	44,473.50
Scappled .... do....	8,890	47,946.22
Granite, cut quoins .... do....	165	6,823.86
Cement, Portland .... barrels..	10,572	29,493.60
Sand .... cubic yards..	2,600	2,508.59
Anchorage and snubbing hooks .... tons..	65	4,337.29
Oils .... barrels..	65	382.79
Steel .... pounds..	6,000	375.38
Rope .... do....	6,000	478.05
Explosives .... do....	9,000	1,082.44
Miscellaneous supplies	....	3,063.60

The cut limestone shown above was all purchased from the representatives of the original contractor for the lock, and it was later found necessary to recut or remodel 610 cubic yards of it before using.

The cement used was practically all Alsen's White Label Portland. The average amount of cement used per cubic yard was as follows, the proportions being approximately 2½ to 1: Face stone (2½ feet wide), 0.09 barrel per cubic yard. Lift wall and coping, 0.17 barrel per cubic yard. Scappled backing (remainder of wall), 0.43 cubic yard. Concrete, 1.25 cubic yards.

Considerable difficulty was encountered at first in obtaining good sand at a reasonable cost. The first sand used came from Memphis, Tenn., and was an excellent article of washed Mississippi River sand, costing $1.10 per cubic yard delivered here. Nine hundred and forty-one cubic yards were obtained from this source. Owing to an increase in railroad rates it was found necessary to purchase bank sand from Sprucepine, Ala. Seven hundred and eighty-seven cubic yards were obtained from this source, at a cost of about $1.40 per cubic yard. Finally, owing to a second advance in the freight rates and other unreasonable actions of the railroad officials, sufficient sand to complete the lock was obtained from the Ohio River at Paducah, Ky., and towed to Riverton on Government barges. Eight hundred and ninety-two cubic yards were obtained in this way.

All of the limestone coping was purchased from The Fossick Company, who operate quarries at Rockwood, Ala. It is an excellent quality of oolitic limestone and cost, delivered, sawed one way, $11.72 per cubic yard.

The granite for the quoins was purchased of the Southern Granite Company, and came from their quarries at Lithonia, Ga. The average cost of this stone, all cut ready to set, was $41.55 per cubic yard.

The coal used came from the mines of Alabama, and cost about $1.90 per ton, delivered.

The average stone used in the lock contains 36 cubic feet.

PLANT.

The additions, improvements, and repairs of plant made during the year cost about $4,000. The following statement gives the total cost of plant used at Riverton and Cherokee, including repairs and additions, and also the present estimated useful value and the amount charged to the particular class of work for which it was used.

TABLE D.—*Total cost of plant used in the construction of the lift lock at Riverton, Ala., and at the Cherokee Quarry.*

RIVERTON PLANT.			
Cable way:			
Total cost complete to date	$9,434.29		
Present useful value		$4,500.00	
Amount chargeable to excavation			$4,934.29
Cable road:			
Total cost complete to date	3,925.29		
Present useful value		1,500.00	
Charge to masonry—conveying materials			2,425.29
Pumping plant:			
Total cost complete to date	2,735.27		
Present useful value		1,500.00	
Charge to excavation			1,235.27
Derricks:			
Total cost complete to date	6,257.71		
Present useful value		3,000.00	
Charge to masonry			2,996.05
Charge to stonecutting			770.00
Charge to excavation			391.66
Hoisting engines:			
Total cost complete to date	4,365.00		
Present useful value		2,500.00	
Charge to masonry—conveying materials			150.00
Charge to masonry—setting			1,500.00
Charge to stonecutting			100.00
Charge to excavation			115.00
Traveling crane:			
Total cost complete to date	8,359.68		
Present useful value		5,000.00	
Charge to stonecutting			3,359.68
Tools:			
Total cost to date	886.42		
Present useful value		300.00	
Charge to masonry			125.80
Charge to stonecutting			100.00
Charge to excavation			360.62
Miscellaneous:			
Plant, buildings, etc., to date, total cost	1,478.44		
Present useful value		500.00	
Charge to masonry			300.00
Charge to stonecutting			100.00
Charge to excavation			578.44
Total for Riverton	37,442.10	18,800.00	18,642.10
CHEROKEE PLANT.[a]			
Total cost complete to date	18,376.74		
Present useful value		5,500.00	
Charged to Cherokee Quarry			12,876.74

[a] See Table B.

Generally speaking, the plant was well designed for the purposes in view, and has proved satisfactory and economical in its operation. The cable road was, however, an exception to the above statement under the conditions existing at the time I took charge of the work. A careful study of the cost of its operation and repairs and consultation with the foreman on the work led to the conclusion, which was afterwards fully justified by our experience, that the work of carrying materials into the lock pit could be better and more cheaply done with mules than with the cable-road machinery. It was therefore abandoned and has not been in operation since.

The traveling crane has been a source of considerable trouble and anxiety, owing to improper proportioning of many of the working parts by the manufacturer. The wearing or breakable parts of the machine have nearly all been changed or remodeled since it has been in use, and it is now in a useful and satisfactory condition and handles our work economically and well. The progress of the whole work is so dependent on the successful operation of this machinery, that it is of the highest importance that it should be so constructed as to preclude any possibility of a serious breakdown or delay. As would naturally be expected, the plant is worn and will require extensive repairs before being used at the upper lock.

EXCAVATION.

The following table gives the detailed cost of excavating the lock pit and disposing of the materials:

TABLE E.—*Total cost of excavation at lift lock at Riverton, Ala.*

Classification.	Earth.	Rock.	Back fill.	Puddle.	Rock fill.	Sloping banks.
Contract work	$37,028.60					
Labor:						
Excavating, etc	14,492.63	$18,491.30	$3,569.19	$1,500.00	$110.00	$768.40
Pumping	1,056.05	1,056.06	317.33			
Miscellaneous supplies:						
Steel		335.83				
Rope	200.00	200.00				
Explosives		1,082.44				
Miscellaneous	450.00	450.00				
Plant:						
Cable way	2,485.75	2,448.54				
Coal	925.00	925.00				
Oils	118.69	118.69				
Pumps	617.63	617.64				
Coal	900.00	900.00	62.54			
Oils	30.00	30.00				
Hoisting engines		115.00				
Derricks	191.66	200.00				
Tools	237.60	123.02				
Miscellaneous	289.22	289.22				
Total	59,022.83	27,422.24	3,949.06	1,500.00	110.00	768.40

SUMMARY.

Classification.	Quantity.	Cost.	Per cubic yard
Earth excavation by contract ... cubic yards	70,930	$37,028.60	$0.52
Earth excavation originally required ... do	30,405	8,665.42	.28½
Earth rehandled ... do	46,675	13,328.81	.28½
Earth, estimated contents lock pit ... do	101,335	59,022.83	.58¼
Solid-rock excavation ... do	16,062	27,422.24	1.70+
Estimated back fill ... do	18,074	3,949.06	.22—
Puddled back fill ... do	3,000	1,500.00	.50
Rock fill in upper entrance ... do	220	110.00	.50
Sloping spoil banks		768.40	
Total cost of excavation		92,772.53	

The actual quantities remaining to be excavated were carefully determined October 30, as follows:

Earth excavation	cubic yards	5,720
Solid rock excavation	do	8,330

Based on these figures, the unit cost of labor and materials for completing the excavation was as follows:

Solid rock	per cubic yard	$0.84
Earth and loose materials	do	.30

This work was done under favorable circumstances, no charge being made for plant or miscellaneous work, and when compared with the unit cost of similar work, including all legitimate charges, emphasizes the uncertainty of unit figures based on observations covering short periods.

The work done by the United States in excavating has been under the most trying and unfavorable circumstances. In the first place, it was taken hold of after the failure of the contractor, who had taken out the cream of the work, having, in fact, subcontracted the greater part of what he is credited with at 16 cents per cubic yard. The piling and sheeting driven by him to retain the banks had the reverse effect, not only causing slides back to the line of the revetment, but filling the pit with lumber, piling, and other débris, which added greatly to the cost of handling. In the disposition of his surplus material he so effectually covered the available space that it was frequently necessary to rehandle the same materials two and even three times before they could be finally deposited. The fact that it was necessary to handle a total of 76,000 cubic yards in order to make an actual excavation of 30,000 shows to what inconveniences we have been subjected. I am fully satisfied that had the United States done the excavating from the start a saving of at least 40 per cent in its total cost would have resulted, besides the saving in time. The actual cost of superintending and inspecting the work done by the contractor was nearly $10,000, as compared with a total of $15,000 for the superintendence, office expenses, and inspection of all the work done since the annulment of the contract.

The back fill given is the actual quantity of earth and rock filled in between the completed walls and the excavated slopes, assumed to have been at 1 on 1. Behind the curved walls at the upper end the filling was thoroughly puddled to prevent the passage of water behind the walls.

About the time the excavation was completed it was decided to slope and sod the spoil banks on both sides of the lock, so as to improve the general appearance of the vicinity A berme 30 feet wide is left at the level of the top of the main walls. The banks are then to be sloped in two terraces, with a 10-foot level halfway to the top. The mound thus constructed on the south side of the lock is to be utilized as a place of residence for the lock keeper, and will be built up to a height of 24 feet above the lock wall, being 1.2 feet above high water of 1897. The slopes are to be sodded with Bermuda grass, and proper roads and drains will be constructed. Enough of this work has already been done to indicate the extent of the improvement, and it is intended to complete it from the entrance basin excavation.

STONECUTTING.

A careful record has been kept throughout the whole progress of the construction of the work done by the stonecutters by means of individual cards showing the dimensions of each stone cut, the nature of the work done on it, and the time expended. From these records Tables F and G, following, have been prepared:

TABLE F.—*Actual unit cost of stonecutting for stonecutters' wages alone for fiscal year 1897.*

Classification.	Cubic yards cut.			Total wages.	Cost per cubic yard.	Remarks.
	Face 2¼ feet wide.	Backing.	Total.			
Sandstone:						
Fine pointed	436	246	682	$3,389.95	$4.97+	Wages 40 cents per hour.
Rough pointed	324	200	524	2,011.90	3.84—	Curved face.
Arch	183	18	201	1,886.85	9.39—	
Lift wall, face	....	....	213	1,125.00	5.28+	
Lift wall, back	....	....	154	545.00	3.54—	
Limestone:						
Coping	....	....	553	3,364.80	6.08+	Sawed one way.
Fine pointed	152	66	218	1,183.80	4.53—	Remodeled.
Rough pointed	40	14	54	178.40	3.30+	Remodeled curved face.
Sills and lift-wall coping	....	....	179	962.60	5.38+	Sawed one way.

TABLE G.—*Cost per square foot (cutters' wages alone) for cutting face, beds, and joints of sandstone—lift-wall stone.*

[Face fine pointed, beds and joints cut to one-fourth inch throughout.]

Designation.	Number cut.	Cubic yards.	Fine point face cut.	Cost per square foot.	Beds and joints cut.	Cost per square foot.	Total wages.	Remarks.
			Sq. ft.		*Sq. ft.*			
Face stone	84	213	10,920	$0.34½	7,476	$0.10	$1,125.00	Face cut on radius of 55 feet.
Backing stone	64	154	....	....	5,400	.10	545.00	Back left rough.

The lift wall was cut at a time when very little other work was going on, and afforded an opportunity to obtain the figures given in Table G. The sandstone works in about the same way as the Berea, Ohio, sandstone, and the limestone similar to the oolitic stone from Bedford, Ind.

The unit costs for the different classes of work, estimated on the same basis used by Mr. Williamson in his annual report for 1896, practically agree with the figures given by him. A comparison of these unit costs (which do not include the cost of plant or any charge for general or miscellaneous expenses) with the total unit costs shown in Table H indicates that the items mentioned increase the cost about 50 per cent.

The following table gives in detail the total and unit costs of stonecutting for the whole lock:

TABLE H.—*Total cost of cutting stone for the lift lock, Riverton, Ala.*

Classification.	Cubic yards cut.	Cutting labor.	Miscellaneous labor.	Miscellaneous supplies.	Plant.	Total cost.	Per cubic yard.
Sandstone:							
Fine pointed	2,444	$18,458.09	$360.00	$360.00	$1,733.00	$20,911.09	$8.56—
Rough pointed	645	4,785.57	100.00	92.00	483.00	5,460.57	8.47—
Rock face	68	476.00	20.00	17.00	90.00	603.00	8.87—
Lift wall	417	2,788.36	50.00	60.00	288.36	3,186.67	7.64+
Arch	491	8,106.48	98.00	100.00	360.00	8,664.48	17.65—
Scabbled backing	5,984	7,175.30	540.00	120.00	254.00	8,089.30	1.35+
Grooves	1,340	1,206.00	102.00	16.00	42.00	1,366.00	1.02—
Total						48,281.11	
Limestone:							
Fine pointed	400	2,628.00	60.00	65.00	300.00	3,053.00	7.63+
Rough pointed	55	385.00	10.00	10.00	40.00	445.00	8.09+
Rock face	18	84.37	5.00	4.00	16.00	109.37	6.08—
Lift wall	115	787.50	15.00	17.00	90.00	909.50	7.91—
Sills and lift-wall coping	179	1,267.41	20.00	24.00	120.00	1,431.41	8.00—
Coping	783	7,026.18	150.00	132.00	589.32	7,897.50	10.09
Scabbled backing	160	241.05	20.00		16.00	277.05	1.73+
Grooves	260	312.00	10.00	8.00	8.00	338.00	1.30
Total						14,460.83	
Grand total						62,741.94	

This table gives the cost of cutting 2½ feet of the face only, the backing attached being estimated as scabbled backing. The cost of cutting the face stone, if the attached backing is considered part of the face stone, will be about 70 per cent of the cost shown above.

The limestone, except the coping, was remodeled stone, and does not give a fair idea of the cost of cutting limestone.

The coping was all sawed one way.

The rough-pointed stone was all cut to a curve on the face.

MASONRY.

The following table gives the total detailed cost of laying masonry for the whole lock:

TABLE I.—*Total cost of laying masonry in the lift lock, Riverton, Ala.*

	Fine pointed (3,452 cubic yards).	Rough pointed (804 cubic yards).	Rock face (96 cubic yards).	Lift wall (622 cubic yards).	Sills (179 cubic yards).	Coping (783 cubic yards).	Arch stone (491 cubic yards).	Quoins (165 cubic yards).	Rubble (18,692 cubic yards).	Concrete (1,053 cubic yards).
Labor:										
Setting	$4,401.22	$1,043.68	$108.65	$650.30	$220.00	$1,237.41	$1,132.67	$275.00	$17,172.45	$3,997.72
Miscellaneous	294.45	32.00	6.00	49.00	8.00	115.00	180.00	6.00	309.78	76.00
Supplies, miscellaneous	103.50	24.00	3.00	20.00	4.80	57.51	14.20	4.20	650.38	30.50
Conveying:										
Labor	1,480.00	320.00	40.00	116.08	16.07	192.00	196.00	82.00	6,221.05	105.00
Plant	345.00	80.00	10.00	22.00	2.00	30.00	50.00	17.00	1,994.29	25.00
Materials	148.00	33.00	4.00	8.00	8.00	13.00	20.00	10.00	546.00	10.00
Mortar materials	1,035.00	241.00	30.00	342.00	100.00	430.00	196.00	48.00	25,065.19	4,515.00
Plant, tools, etc	517.00	120.00	14.00	94.50	25.80	196.55	120.00	35.00	2,794.00	105.00
Total cost	8,324.17	1,893.68	215.65	1,501.88	384.67	2,271.47	1,908.87	477.20	54,753.14	8,864.22
Unit cost	2.41	2.35	2.25	2.41	2.15	2.90	3.88	2.90	2.93	8.42

NOTE.—The fine-pointed, rough-pointed, and rock-face work is estimated for a width of 2½ feet.

The average unit cost of laying for the work, including a proper proportion of the miscellaneous expenses and the cost of plant as shown above, is $2.80 per cubic yard.

In order to give a better idea of the dimensions of the lock and the quantities entering into its construction, the following "general description of the lift lock" is taken from the Annual Report of the Chief of Engineers for 1896:

"Detail dimensions of the lock are given on Plate No. 1 of the accompanying drawings. The principal dimensions may be summarized as follows:

	Feet.
Total length of lock	551
Clear width	80
Height of lock walls	37
Width of bottom course, lock walls	21¼
Width of coping course, lock walls	5
Width of coping course, gate abutments	30
Length between hollow quoins	350
Length between lower and guard gates	40
Height of lift walls	25¼
Width of bottom course, lift wall	10
Width of coping course, lift wall	6
Width of bottom course, gate abutment	34

"There are fifteen courses, varying from 3 feet 6 inches to 1 foot 9 inches. The first and second courses from the foundation are of limestone, as are also the fourteenth and fifteenth, the latter being the coping. The remaining courses are sandstone. The lift wall is built of limestone.* The minimum and maximum courses are respectively 3 feet and 3 feet 6 inches (coping 2 feet 9 inches). The miter sills and wall are circular arcs, their upstream faces having 65 feet 1 inch radii."

The first stone was set on September 30, 1895, and was the south pintle stone at the lower gate recess. The last stone was set June 15, 1897, and was the south stone of the guard gate sill. During this time a total of 1,053 cubic yards of concrete, 6,614 cubic yards of cut stone, and 18,692 cubic yards of backing were laid. Deducting time lost due to floods and other causes beyond control, some two and one-half months, the average laid per month was 1,400 cubic yards. The maximum, 2,762 cubic yards, was laid in the month of June, 1896.

From one to four derricks have been in use, and the following gives the derrick record for the whole work:

Fiscal year.	Number of derricks used.	Number of days setting.	Cubic yards set.	Cubic yards set per day per derrick.
1896	1 to 4	456	12,991	28½
1897	1 to 4	385	12,315	32
Total	1 to 4	841	25,306	30

The average cost per cubic yard for laying masonry has been $1.93. This included all labor and materials expended by the setting gang, but did not include the cost of plant.

The following is a summary of the figures contained in the preceding tables, and gives the total quantities, as well as the unit and total cost, of the various items entering into the lock construction. The expense of the Chattanooga office is not included.

TABLE J.—*Total detailed cost of lift lock, Riverton, Ala., January 1, 1893, to June 30, 1897 (work completed), not including Chattanooga office expenses.*

Kind of work.	Quantities.	Cost.	Total.	Per unit.
Superintendence:				
Work done by contractor	....	$9,808.38	....	....
Days work by United States	....	14,751.86	....	....
Miscellaneous surveys	....	406.96	....	....
Watchmen	....	2,514.45	....	....
			$27,481.65	

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*Changed to sandstone, except coping.

TABLE J.—*Total detailed cost of lift lock, Riverton, Ala., etc.*—Continued.

Kind of work.	Quantities.	Cost.	Total.	Per cent.
Excavation:				
Earth .... cubic yards..	101,335	$59,022.83		$0.58¼
Rock .... do....	16,062	27,422.24		1.70+
Back fill .... do....	18,074	3,949.06		.22—
Rock fill .... do....	220	110.00		.50
Puddle .... do....	3,000	1,500.00		.50
Sloping spoil banks		768.40		
			$92,772.53	
Fine pointed masonry:				
Stone .... cubic yards..	3,452	20,412.12		5.91+
Cutting .... do....	2,844	23,964.09		8.42+
Setting .... do....	3,452	8,324.17		2.41+
Total .... do....	3,452	52,700.38		15.26—
Rough pointed masonry:				
Stone .... do....	804	3,811.98		4.74+
Cutting .... do....	700	5,905.57		8.44—
Setting .... do....	804	1,893.68		2.36—
Total .... do....	804	11,611.23		14.44+
Rock face masonry:				
Stone .... do....	96	413.33		4.31—
Cutting .... do....	86	712.37		8.28+
Setting .... do....	96	215.65		2.25—
Total .... do....	96	1,341.35		13.97+
Lift wall masonry:				
Stone .... do....	644	3,864.59		5.70+
Cutting .... do....	532	4,096.17		7.70
Setting .... do....	644	1,501.88		2.33+
Total .... do....	644	9,462.64		14.69+
Sills and lift wall coping:				
Stone .... do....	179	1,946.21		10.87+
Cutting .... do....	179	1,431.41		7.99+
Setting .... do....	179	384.67		2.15—
Total .... do....	179	3,762.29		21.02
Coping masonry:				
Stone .... do....	783	9,776.13		12.48—
Cutting .... do....	783	7,897.50		10.08
Setting .... do....	783	2,271.47		2.90
Total .... do....	783	19,945.10		25.48—
Cut stone arch masonry:				
Stone .... do....	491	2,172.54		4.42
Cutting .... do....	491	8,664.48		17.65
Setting .... do....	491	1,908.87		3.89
Total .... do....	491	12,745.89		26.00
Quoins (granite):				
Cut granite .... do....	165	6,823.86		41.36
Setting .... do....	165	477.20		2.89
Total .... do....	165	7,301.06		44.25
Rubble backing masonry:				
Stone .... do....	18,692	90,371.52		4.84
Scappling .... do....	6,144	8,366.35		1.36
Setting .... do....	18,692	54,753.14		2.93
Total .... do....	18,692	153,491.01		8.21
Concrete masonry, total .... do....	1,053	8,864.22		8.42
Grooves .... square feet..	1,600	1,704.00		1.06
Total cost of masonry	26,359		282,929.17	10.73
Anchorage and irons, cast iron .... tons..	27.8	1,591.53		57.25
Wrought iron .... do....	37.2	2,868.00		77.09
Setting .... do....	65.0	520.00		8.00
Total .... do....	65.0		4,979.53	76.60
Expense due to high water			3,923.82	
Total field cost of lock			412,086.70	

TABLE J.—*Total detailed cost of lift lock, Riverton, Ala., etc.*—Continued.

Kind of work.	Quantities.	Cost.	Total.	Per cent.
Lower entrance, miscellaneous	....	$483.69	....	....
Upper entrance and canal	3,600	665.11	....	....
			$1,148.80	
Present useful value of plant	....	....	24,300.00	....
Rough sandstone on hand.....cubic yards	822	3,626.07	....	....
Rough limestone on hand.....do	129	297.21	....	....
Scappled sandstone on hand.....do	100	400.00	....	....
Sand on hand.....do	200	300.00	....	....
			4,623.28	
Total field expenditures	....	....	442,158.78	....

A comparison between the quantities actually entering into the construction of the lock and those used in preparing the original estimate of cost is shown in the following statement:

Classification.	Original estimate.	Actual quantities.	Remarks.
Excavation.....cubic yards	97,480	101,335	
Rock excavation.....do	8,410	16,062	
Concrete masonry.....do	66	1,053	Filling over arches and leveling foundation.
Rubble masonry.....do	19,085	18,692	
Fine point masonry.....do	2,974	3,452	
Rough point masonry.....do	692	804	
Rock face masonry.....do	224	96	
Sills, lift wall.....do	754	642	
Sills and lift wall coping.....do	....	179	
Quoins.....do	196	165	Coping quoins not set.
Lock coping.....do	998	783	
Well coping.....do	17	....	Classed as rubble.
Cut stone.....do	173	491	Arches.
Brick.....do	27	....	Not used.
Grooves and checks.....square feet	1,400	1,600	
Filling.....cubic yards	16,932	18,074	
Stone filling.....do	1,488	222	At upper entrance. Not completed.
Paving.....do	367	....	Do.
Puddle filling.....do	....	3,000	

The main differences are in the rock excavation and the concrete masonry, which are explained by the fact that more of each was required than was originally contemplated.

The original estimate of cost of the lock was $399,324. The actual cost, after deducting the present useful value of the plant and of materials on hand, has been about $412,000, which, considering the manner in which the work was done—that is, by a combination of the contract and day-work systems—is unusually close.

OFFICE WORK.

The cement used being a well-known standard brand, it was not thought necessary to make extended or elaborate tests. Tests to determine the time of setting were frequently made. One series of tests was made in August and September, 1896, which showed that the specification requirements were being complied with. In December, 1896, and January, 1897, a second series was made, to determine the relative values of the sands used in the work and to satisfy ourselves that certain sand taken from the excavation and used for concrete could be relied on, all of which was satisfactorily shown. In April, May, and June a third series of tests was made, to determine the extent of the deterioration in 200 barrels of cement on hand since November, 1896, and which was exposed to rain and dampness during the flood. These tests indicate that very few barrels were seriously injured. These were marked and not used at all, or were placed where strength was not essential, and in using the remainder the apparent differences in strength were more than made up by increasing the proportion of cement to sand over the customary proportion.

Many of the samples that showed weakness on the seven-day test gained strength rapidly at thirty and sixty days, and it is confidently believed that the ultimate strength of all this cement will be nearly normal.

A series of tests have also been started for the purpose of selecting a cement for use in constructing the walls for the entrance to the lock. As the requirements and specifications are not nearly so rigid as for the lock, it is thought that in all probability a cement can be found that will effect a considerable saving on the cost of those walls.

The tensile strength of the Cherokee sandstone was determined, roughly, by preparing test pieces by hand and breaking them in the cement-testing machine. Twelve samples were broken, showing a strength per square inch of from 540 to 720 pounds, and an average strength of 602 pounds per square inch, which is probably about the ultimate strength of the mortar used in the lock.

ENTRANCE TO THE LIFT LOCK.

The matter of a suitable entrance to the lift lock has been under serious consideration for the past six months. A number of plans have been prepared and discussed. The matter was culminated, however, by the appointment by the Chief of Engineers, United States Army, of a Board of Engineers to meet at Chattanooga on June 7, for the purpose of considering the question. This Board visited the lock site on June 9, and decided on a plan which differs from the plan suggested by you, mainly, in the height of the walls. The plan proposed by the Board of Engineers may be briefly described as follows:

The south wall of the entrance is the extension of the south lock wall at full height (32¼ feet), a distance of 470 feet to the river. The north wall begins at the end of the north lock wall with a curve of 40 feet radius for 25°, and then extends at an angle of 25° with the axis of the lock to the river. This wall is 32¼ feet high and 180 feet long. Both walls terminate with a pier 15 feet in diameter. The river bank for a short distance above and below the entrance will be sloped and paved with riprap.

A sketch embodying the suggestions of the Board and a design for the section of the walls, accompanied by a detailed estimate of cost, amounting to $147,570, has been prepared by me and submitted for your action.

WATERSHED.

A careful survey has been made of the watershed tributary to the canal. The total area of the watershed is 9,500 acres, divided into thirteen separate districts, varying from 35 to 3,500 acres. The run-off from this area during continued rains, like those of March, 1897, described later under head of "high water," will be practically equal to the total rainfall. It may, therefore, be assumed that during a period of maximum rainfall—say at the rate of 3 inches per hour, which is the maximum observed at Florence—it will be necessary to provide for a flow through the canal of approximately 3,000 cubic feet per second, which would require an overflow opening, approximately, 80 by 6 feet; or, if the water is allowed to be backed up by the gates to a height of 1 foot above the overflow, a total approximate length of overflow of 1,300 feet would be required.

The study of this question, which is an important one, has only been carried far enough to indicate that a structure of considerable magnitude will be required to safely care for this water. The figures given above are crude and strictly approximate.

UPPER OR GUARD LOCK.

The necessary steps have been taken to acquire, by condemnation, 21¼ acres of land on the bluff south of the upper lock site for a residence and other buildings. This land connects with the land already owned by the United States, and all lies above high-water mark. Preliminary plans have been made for the assistant engineer's residence, which will eventually be occupied by the lock keeper.

Detailed plans for caisson guard gates were completed by Mr. D. W. Church as a part of the plans prepared by him for the upper lock. Prior to my appointment here I made a careful study for comparative purposes of several forms of gates, and have prepared preliminary designs for straight gates for the upper lock, which indicate a very decided economy for this form of gate over any other considered. The design was based on the use of top and bottom horizontal girders, spaced about 4½ feet apart and sheathed with buckled plates. As compared with curved gates of similar height this preliminary design indicates a saving of over 40 per cent in the weight, in addition to a very material reduction in cost of construction, due to its simpler form.

An investigation is being made to determine the best and most available quarry for use in constructing the upper lock. A number of quarry sites have been visited and inspected, and samples therefrom have been tested and their physical characteristics determined.

THE FLOOD OF 1897.

The year 1897 will be characterized below Decatur as the year of the great flood. The flood, which was inaugurated by heavy rains at the head waters of the river, commenced February 23, with the gauge reading 7.5 feet. The reports from the upper river were alarming, but on reaching a height of 26.6 feet on March 2, it fell rapidly to a gauge height of 14.3 feet on March 6. Beginning March 5 there was almost daily rain for the remainder of the month. Between the 10th and the 20th the rain was abnormal. The heaviest rainfall at Riverton occurred between 10 p. m. on the 17th and 1 p. m. on the 19th.

During this time I am of the opinion that between 7 and 8 inches of rain fell. Between March 6 and 17 the river had risen rapidly from 14.3 feet to 40 feet. During the night of the 18th it rose 4.2 feet; for part of the time the rise was at the rate of 6 inches per hour, and this at practically the crest of an unprecedented rise. The crest height, 50.3 feet, on the gauge at the lift lock, was reached between 2 and 5 a. m. on the 20th. The water fell, slowly at first and until April 3, when the gauge read 19.4 feet. At this time a third rise began, which reached its crest height, 30.1 feet, at 6 a. m., April 11. The normal low-water stage, 6 feet, was reached about May 1, making the total duration of the flood about two months.

This flood, although surpassing all previous ones of record, was purely local, and did not extend above Decatur as a flood of any magnitude. The records of the United States Weather Bureau show that the rainfall at stations within a radius of 25 miles of Florence, Ala., was heavier by more than 50 per cent than at any other points in the Tennessee Basin. The rainfall record at these stations, from the 9th to the 19th of March, is as follows:

Date.	Decatur.	Florence.	St. Joseph.	Newburg.
	Inches.	*Inches.*	*Inches.*	*Inches.*
March 9	0.39	0.09	....	0.21
March 10	.17	.55	0.96	.39
March 11	.18	.85	1.09	1.29
March 12	2.56	1.96	1.45	2.42
March 13	.08	....	....	.01
March 14	1.13	2.15	1.42	1.84
March 15	....	1.00	.82	1.39
March 16	1.75	.50	.42	1.03
March 17	.05	....	....	....
March 18	.51	5.15	4.89	3.56
March 19	4.45	.09	3.04	1.80
Total	11.27	12.34	14.09	13.94

Decatur is east, St. Joseph north, and Newburg south of Florence.

The height attained exceeded the flood height of 1882 and 1867 by 2¼ feet at Riverton, and by 2 feet at the guard lock. The fall of the water surface over Colbert and Bee Tree Shoals between the lift and guard locks was practically wiped out, being only 3.6 feet when the water was highest. The observed fall at low water, with the Riverton gauge at —1.6, is 25.6 feet. Notwithstanding the fact that this flood was unexpected and unprecedented, and that our preparations were entirely inadequate, the actual damage sustained by the United States was practically confined to the wrecking of the temporary buildings at the lock site and the loss of a small quantity of tools and supplies. Of course a very considerable expense was caused by the loss of time and the necessity for securing and caring for the property. As soon as it was certain that the lock would be flooded an opening was cut through the levee and the lock filled through a wooden sluice box built for the purpose. In this way it was possible to regulate the filling, which was done without accident or washing any earth into the lock pit. When the water was pumped out the deposit in the bottom of the lock did not exceed 1 inch. The flood occasioned about two months' loss of valuable time.

GENERAL AND MISCELLANEOUS.

But one accident of a really serious nature has occurred during the construction of the lock, and that was due to the acknowledged carelessness of the chief sufferer from it. The accident was caused by an explosion due to an attempt to remove an unexploded charge of giant powder discovered in the rock excavation. Four men were injured. One had an arm broken, another a leg, a third several ribs, and the fourth, an experienced powder man, who was removing the charge, had both eyes destroyed and was otherwise badly injured.

It is to be regretted that in cases of this kind no provision can be made by the United States representatives for proper medical attention and care of injured men. In this particular instance the men had little or no means to provide for themselves, and were practically dependent on the charity of the resident physicians.

Photographs of the completed lock accompany this report.

Mr. John Porteous, who has acted as inspector and superintendent at the lift lock, and has been connected with the work from its inception, is entitled to credit for faithful and efficient services rendered.

Very respectfully, your obedient servant,

G. T. Nelles, *Assistant Engineer.*

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.

REPORTS OF MR. F. B. WILLIAMS, ASSISTANT ENGINEER.

Engineer Office,
Chattanooga, Tenn., June 18, 1897.

Captain: I have the honor to submit the following report on the completion of the survey of the Tennessee River below Riverton, Ala.:

FIELD WORK.

According to instructions, I left Chattanooga September 27, 1896, and reached Muscle Shoals Canal September 28. One day was spent in getting quarter boat and property ready for the survey. Owing to the low stage of the river the steamboat could not get over the shoals, and the quarter boat had to be run by hand, with sweeps and poles, all the way to Fort Henry, Tenn. (where the field work of 1895 closed), a distance of 200 miles.

Owing to the strong upstream winds during the daytime a large part of the distance was run after dark, and it required ten days to make the trip. Members of the party were picked up at various places along the river most accessible to them, and a complete organization was effected at Fort Henry October 10, as follows: F. B. Williams, assistant engineer, in charge; J. E. Hall, I. C. Brewer, and E. B. Wheeler, transitmen; J. F. Ghormley and Charles W. Negley, levelmen; 1 leadsman, 4 recorders, 4 rodmen, 5 axmen, 6 boatmen, 1 watchman, 1 cook, and 2 waiters; making a total of 30.

The methods employed were the same as those used during the previous year (1895). (See Report of Chief of Engineers, Appendix B B, p. 2036.)

Temporary gauges were established at Johnsonville, Tenn., mouth of Sandy, Tenn., Birmingham, Ky., and Haddox Ferry, Kentucky, and these were read twice a day during the survey.

The total amount of work done was as follows:

	Right bank.	Left bank.
Stadia lines run .... miles..	63.9	65.4
Number of courses	486	672
Level lines run .... miles..	62.4	62.7
Bench marks established	50	48

Number of ranges sounded, 613 = 70.5 miles, including chutes.

The amount of sickness in the party was very much less than it was the year before, owing, I think, to the use this year of boiled water for drinking. Considerable sickness was experienced by those who did not drink the boiled water, but those who did drink it were free from malaria.

The survey was completed to the mouth of the Tennessee River, and included a part of the city of Paducah, Ky.

The party was disbanded November 21, having been in the field forty-two days from the time that work was begun at Fort Henry.

The total cost of subsistence was $465.72, or an average of about 31¼ cents per man, per day; amount paid out in salaries during the field season was about $1,900, including gauge readers' salaries; traveling expenses $58.85; making a total cost of survey about $2,424, or $39.74 per mile, which includes the ten days employed in moving quarter boat to Fort Henry, Tenn.

OFFICE REDUCTION.

Mr. J. E. Hall and Mr. E. B. Wheeler, computers, assisted in the office work, beginning Jannuary 8, 1897.

Latitudes and departures were computed for all courses (1,158), frequent closures of loops and adjustments being made. Stations were then plotted, to a scale of 500 feet to 1 inch, on charts 2 by 3 feet, so that a continuous map is obtainable by joining these charts.

The "Ockerson rollers" were used in putting on the topographical signs beyond the top of bank.

Seventeen charts were required to cover this part of the river, making a total of 63 charts, covering 226¼ miles, from Riverton, Ala., to Paducah, Ky. These 17 charts were completed about April 1, 1897, at a cost of about $690.

The work of making tracings of the entire set of 63 charts was then begun, and 50 of these tracings have now been made. The office force on this work was reduced to 2 men May 7, 1897, by the resignation of Mr. J. E. Hall.

After checking up the level notes it was found that our levels gave the elevation of "zero of Paducah gauge" 279.16 feet above mean Gulf level at Biloxi, Miss., which is 8 feet lower than the elevation given by the United States Weather Bureau. The Weather Bureau's elevation is probably erroneous, as it was taken from a single line of railroad levels, while Tennessee River elevation was determined by a double line of ordinary levels, starting with "precise-level" elevations, with water surface and frequent river crossings to check up by.

The bed of the Tennessee is composed almost entirely of gravel, and where shoal places occur, on the lower river, at the heads of islands and bars, everything seems favorable for improving the channel by dredging.

Very respectfully, your obedient servant,

F. B. Williams, *Assistant Engineer.*

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.

Engineer Office,
Chattanooga, Tenn., June 19, 1897.

Captain: I have the honor to submit the following report on the survey of the proposed site of city wharf, Chattanooga, Tenn.:

It appears that prior to 1876 a strip of land lying along the Tennessee River between Montgomery avenue and Hooke street, Chattanooga, Tenn., was set apart for a public wharf. This, however, was never used and no improvements were ever made.

All necessary information in regard to the location of this old city wharf site was obtained from the city engineer, Mr. Hooke.

Computations based upon data obtained from an old blue print of city wharf site show the east side of wharf limits, 950.7 feet long, running from the north side of Montgomery avenue to the north side of Hooke street, making an angle of 69° 24′ with the center line of Montgomery avenue.

Mr. E. B. Wheeler assisted in making the survey, and the crew of the U. S. steamer *Colbert* was used to complete the party.

A topographical survey was made of the wharf site and vicinity by transit and stadia method. A line of levels, based on city datum (which is the zero of Chattanooga gauge), was run between stadia stations and along the shore line. Cross sections were also made every 200 feet with a lock-hand level and a tape.

Thirteen ranges, about 100 feet apart, were sounded from the shore out to the channel and 3 of these ranges extended across the river. Soundings were located with transit and stadia.

Five borings, from 2 to 4 feet in depth, were made with a pointed steel rod, to ascertain the character of the river bed.

The fall of the river for the 1,000 feet in front of the wharf site is about one-tenth of a foot. The river bed has a gradual slope from the shore out, and is composed of gravel, with a slight mixture of sand in some places. No rock was found.

At low water there is about 9 feet of water in the channel.

The bank is very uneven and cut up, and the surroundings are very bad. Two open sewers from 2 tanneries empty into the river here, and the city garbage dump is at the lower end of the site. Large quantities of slag have been thrown out over part of the ground by the Chattanooga Iron Company.

A map of the site, drawn to a scale of 80 feet to 1 inch, has just been completed.

Very respectfully, your obedient servant,

F. B. Williams, *Assistant Engineer.*

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.

Commercial statistics of Tennessee River above Chattanooga, Tenn.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Grain	25,911	55,116	45,433	51,153	$783,685.00
Iron ore	11,988	14,567	66,347	61,044	61,400.00
Lumber	3,464	7,957	14,995	16,819	105,698.00
Logs and wood	225	40.000	82,680	359.204	467,721.20
Live stock	528	1,089	1,249	4,996	182,676.00
Sand	1,763	1,225	1,500	80,403	16,003.00
Tan bark	800	27		2,067	11,741.00
Flour	644	1,844	1,495	5,503	275,150.00
Railroad ties	88		1,000	5,245	14,223.00
General merchandise	25,615	38,579	84,011	6,547	589,230.00
Cotton		14	27	258	39,000.00
Cotton seed		400		30	450.00
Coal			7,105	6,275	9,650.00
Hay			1,827	5,652	81,745.00
Shingles			5,250	64	1,425.50
Brick			2,337	1,295	4,217.00
Tile				225	9,000.00
Marble				12,000	40,000.00
Peanuts				75	1,950.00
Hoop poles				2,900	1,900.00
Fertilizer				560	24,100.00
Tobacco				225	5,300.00
Produce				1,326	61,620.00
Staves				50	137.50
Total	71,026	160,818	265,256	623,915	2,788,022.20

Number of passengers transported (1896), 38,240.

Commercial statistics between Chattanooga, Tenn., and Decatur, Ala.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Lumber	58,525	12,738	22,290	8,100	$49,932.00
Cotton	190	4,095	3,970	4,188	480,120.00
Live stock	197	921	234	798	11,850.00
Grain	1,798	7,559	13,716	13,165	150,264.20
Flour	342	3,288	3,874	4,143	203,722.00
Cotton seed	24	1,073	1,088	966	12,701.00
General merchandise	5,578	15.001	9,465	13,816	1,571,254.00
Logs and wood	6.090	122,011	1,287	40,693	69,903.00
Iron ore	4,581	6,664	46,610	36,686	39,502.00
Staves			66		
Peanuts			25		
Coal			2,056	3,201	6,402.00
Hay			47	876	9,095.50
Tan bark			1,150	101	6,341.00
Sand			8,984	2,892	1,931.00
Stone			2,500		
Produce				602	43,202.00
Iron, pig				375	4,405.00
Brick and tile				804	25,523.00
Total	77,325	173,355	117,357	131,406	2,686,147.70

Number of passengers transported (1896), 21,163.

Commercial statistics between Florence, Ala., and Paducah, Ky.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Iron, pig	14,454	6,664	49,384	64,467	$752,845.00
Staves	4,141	2,251	27,296	29,679	151,516.00
Lumber	104,000	20,028	91,824	121,855	752,022.80
Cotton	1,837	4,437	16,317	4,605	602,120.00
Peanuts	2,029	640	8,910	3,598	299,100.00
Live stock	3,090	2,238	4,250	7,988	47,000.00
Hoop poles	124	880	68,052	1,604	8,025.00
Grain	12,121	9,990	24,283	2,948	148,108.00
Flour	4,352	4,510	6,600	5,085	212,225.00
Cotton seed	24	1,076	....	2,320	24,760.00
Sand	701	4,922	14,487	4,700	3,292.00
General merchandise	28,177	22,089	100,072	134,059	11,075,288.00
Logs	30,300	192,012	112,432	125,634	420,952.00
Railroad ties	139,203	37,175	194,501	184,010	391,584.00
Coal	....	....	92,835	127,024	211,068.00
Stone	....	....	3,666	2,050	1,150.00
Tan bark	....	....	34	172	18,620.00
Tobacco	....	....	310	428	21,000.00
Wood	....	....	34,060	41,684	56,184.00
Iron ore	....	....	....	151	246.00
Total	344,553	308,914	960,959	864,061	15,192,055.80

Number of passengers transported (1896), 32,337.

List of steamboats (stern-wheel) plying on the Tennessee River above Chattanooga, Tenn.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Onega and 1 barge	104.6	18	2.5	74.77	28
Lucile Borden and 6 barges	86	14	2.5	55.32	168
Telephone and 6 barges	93	19	2.6	97.47	168
Flora Swan and 7 barges	98.11	13.11	2.8	57.81	210
Gladys and 1 barge	76.11	11	2.8	30.91	45.30
J. W. Bussell and 1 barge	76	9	2.8	24.60	47.14
Tallassee	60	12	2	22.16	....
Spring Hill and 9 barges	136	26.6	4	156.83	2,700
E. P. Dawson and 4 barges	60	10	2.8	29.80	157.20
Key City and 1 barge	80	15	3.2	59.45	45
Clinton B. Fisk and 2 barges	100	18	3.4	78.89	164.60
Ocoee No. 2 and 3 barges	51.5	12.5	1.6	19.18	117.78
Lora	70	12	2.5	22.16	....
Maud and 4 barges	79	16.5	3.2	23.30	800
C. M. Fouche	93	14	2	61.12	....
Kingston and 3 barges	55	11	3	37.80	145
Oliver King	60	8	2.6	29.30	....
J. C. Warner and 2 barges	142	31.6	4.6	201.05	300
J. P. Kindrick and 2 barges	112	20	3.7	125.71	300
Eclipse	39	9	3	9.72	....
City of Knoxville	130	18	3	147.60	....
J. W. Hart	41	7	2.1	5.63	....

In all, 22 steamboats of 1,369.58 tons burden net, and 52 barges of 5,396.02 tons capacity.

List of steamboats (stern-wheel) plying on the Tennessee River below Chattanooga, Tenn.

BETWEEN CHATTANOOGA, TENN., AND DECATUR, ALA.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Huntsville and 2 barges	125	24	4	89.99	176
Hattie McDaniel and 2 barges	90.5	18	2.5	90.63	1,247.50
J. C. Warner and 2 barges	142	31.6	4.6	201.05	300
J. P. Kindrick and 2 barges	111	20	3.5	128.71	300
Spring Hill and 9 barges	136	26.6	4	156.33	2,700
Mattie Ivy	....	....	....	....	....
City of Chattanooga and 3 barges	134	27.8	3.6	167.60	600
Luke Pryor, jr	....	....	2	124.26	....
B. F. Young and 26 barges	120	24	4	160.68	8,118.50

In all, 9 steamboats of 1,119.25 tons burden net, and 46 barges of 13,442 tons capacity.

BETWEEN FLORENCE, ALA., AND PADUCAH, KY.

City of Paducah	183	37	5.25	700	....
City of Sheffield	180	32	5.5	750	....
Steamer Clyde	185	33	6	580	....
John L. Lowry	108	16	3.6	54.15	....
Wm. Towle and 2 barges	90	16	3.5	63.86	500
Fred. Nelles	96	19	4	57.17	4,054.20
Clayton H. Webb and 5 barges	112.9	24.7	3	96.7	
W. J. Bryan	....	....	....	....	....
Maggie Belle and 30 barges	95.6	18.4	3.6	52.81	13,350
Artemus Lamb and 14 barges	140	30.6	4	176.73	5,600
Peter Honts	....	....	....	100	2,841.25
Lula E. Warren and 8 barges	....	....	....	....	
Dolphin and 13 barges	135.8	22.8	4.8	156.16	5,200
Barge Grace	115	26	8	500	....
Manie Bauer and 4 barges	73	17.5	3	45.36	2,400
Longfellow	112	19.06	14.3	93.59	3,640
Gus Genin and 8 barges	120	20	4	130.09	
Mayflower	....	....	....	963	....
Edgar Cherry and 1 barge	152	27.4	5	266.48	250
R. A. Speed and 11 barges	124	22	4.2	140.57	5,550
Steamer Kenton and 6 barges	106.2	33	5.2	153.08	300
John D. Lewis	148.2	28.2	4	266.41	....
Ashland City and 1 barge	120	20	3.9	94.55	200
Frank Barnett	50.6	9.2	2.8	7.61	....
City of Chattanooga and 3 barges	134	27.8	3.6	167.60	600
Emma Cooper	95	25	3.3	79.10	528
Penguin and 2 barges	80	16.6	3.4	60.68	
Dick Clyde and 4 barges	96	17.4	3.9	76.84	1,000
Tug Ida and 5 barges	80.5	14.8	7	37.78	300
Mary N. and 5 barges	69	14	3	36.54	300
John Barrett	124.8	31	4	187.23	18,000
Charlie McDonald and 20 barges	147	30	4.5	259.52	
Jennie Gilchrist and 6 barges	100.5	18.5	3.8	74.48	1,400
Geo. W. Parker	266	46.5	7	995.16	....
H. S. McCombe	195.8	45.6	6	395.91	....
Grace Morris	100	20	3.6	78.88	....
Josie and 10 barges	146.2	28.6	2.6	233.70	5,000
B. F. Young and 26 barges	120	24	4	160.68	8,118.50
Luke Pryor, jr	....	....	2	124.26	....

In all, 39 steamboats of 8,419.62 tons burden net, and 184 barges of 74,181.95 tons capacity.

REPORT OF BOARD OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., June 7, 1897.

The Board met at 10 a. m., pursuant to the foregoing order. Present, all of the members. The Board then proceeded to consider all of the information on file in this office relating to the subject which it was appointed to investigate. A large number of letters was read, copies of which are transmitted herewith, numbered 1 to 24, inclusive. Six blue prints were also examined and are herewith transmitted.

On the 9th of June the Board visited Riverton, Ala., the site of the lock, and personally examined it and the proposed entrance. On June 10, the Board having completed the duty assigned to it, adjourned sine die.

As a result of its investigation and study, the Board has the honor to submit the following report:

The duty assigned to the Board was to examine into and report upon a project prepared by Capt. Dan. C. Kingman, Corps of Engineers, for the construction of the entrance to the lift lock at Riverton, Ala. This project was submitted to the Chief of Engineers in a letter dated April 28, 1897, which letter is herewith returned. This project proposed, briefly, to excavate the earth and rock down to the level of the bottom of the lock and outward to the low-water line of the river; to curve the lock walls outward on the arcs of circles; to retain the slope of the excavation on the south side by a wall about 18 feet in height, and above this to protect the slope by a stone pavement. On the north side the point of land lying between the entrance and the river was to be shaped up and protected on the entrance side by a low wall conforming to a slope of 1 on 2, and above the water line by a stone pavement. On the river side the point was to be protected by a heavy riprap.

The Board had to consider first whether this proposed form of entrance afforded a sufficient basin below the lock, and second, whether the method of retaining and protecting the slopes was the best suited to the particular case.

The Tennessee River, at the place where it will be entered from the canal, makes a curve with a radius of about 2 miles. The axis of the lock makes an angle with the river bank of about 20 degrees. The low-water width of the river is about 1,000 feet; its cross section is symmetrical, the deepest water being found near the middle of the river. The current in the river at this place is at no time excessive. The bank of the river for nearly 2,000 feet below the lock is generally smooth and even, and the regular steamboat landing of Riverton is situated upon it.

For these reasons it appears to the Board to be unnecessary to excavate or to otherwise construct a large basin for the reception of boats at the lock. The whole river itself is a basin and can be used as such. The size of the entrance proposed in the project before referred to is, therefore, considered by the Board to be sufficient.

The method proposed for retaining and protecting the slopes at the sides of the excavation is not, however, considered to be desirable. Experience at the Louisville and Portland Canal has clearly indicated that paved slopes are objectionable. It is difficult to construct them of sufficient strength to resist the shock of heavy boats, and it has been found that boats easily ground upon them, and that particularly in the case of the lightly constructed boats used for the transportation of coal they may be seriously injured and even destroyed by such grounding. The Board therefore disapproves of using the paved slopes in the vicinity of the lock, and it is proposed to so far modify the project of Captain Kingman as to provide that the south slope to the entrance shall be protected by a masonry wall built to the same height as the lock wall at its lower end and extending about 500 feet to the river bank. That the slope on the north side of the entrance shall be similarly retained by a wall about 180 feet in length, making an angle of 25 degrees with the axis of the lock and built to the same height as the south wall. The river slopes beyond these walls to be protected for a sufficient distance by hand-laid riprapping.

The dimensions and mode of contruction and the estimate of cost of the proposed entrance are fully set forth in a letter of Assistant Engineer G. T. Nelles, which was prepared for this report by him under the direction of the Board. A copy of this letter is herewith, and is made a part of this report.

Respectfully submitted.

DAN C. KINGMAN,
Captain of Engineers.
GEO. W. GOETHALS,
Captain of Engineers.
J. G. WARREN,
Captain of Engineers.

REPORT OF MR. G. T. NELLES, ASSISTANT ENGINEER.

TENNESSEE RIVER IMPROVEMENT,
ENGINEER OFFICE, UNITED STATES ARMY,
Riverton, Ala., June 12, 1897.

CAPTAIN: I have the honor to submit a detailed estimate of cost, and a sketch of a design for the entrance to the lift lock, prepared in accordance with the instructions of the Board of Engineers, United States Army, which convened here June 9.

The entrance is made by extending the lock walls out to the river at full height (32½ feet). The south wall is straight in the extension of the south lock wall for a distance of about 475 feet. The north wall is curved to the right on a radius of 40 feet, and then extended to the river at an angle of 25° with the axis of the lock, for a distance of 180 feet. Both walls terminate in a full height pier 15 feet in diameter.

General.—The main walls of the lock were designed to withstand a pressure due to water standing behind them at reference 28, in addition to earth pressure. In the present case it is not thought necessary to provide for a water pressure by increasing the thickness of the walls, but it is proposed, and made as much a part of the project as the walls themselves, to provide weep holes through the walls, and by the manner of placing the back filling, which is to be rock from the excavation, to provide drainage, so that the accumulation of water behind the walls will be impossible.

Owing to the existence of bed rock up to reference 6.5 throughout the area occupied by the entrance, into which the bottom 6½ feet of the wall will be built and bonded, the height of the wall, so far as the effects of the earth pressure is concerned, will be 26 feet. The design is based on this height, the bottom courses to be so built as to maintain this condition under all circumstances; and in making the estimate the quantities given are on the supposition that the bottom 6½ feet will be 1 foot wider than the course immediately above it.

Design of the walls.—A preliminary section was obtained by assuming a mean thickness of 9½ feet, which for a 5-foot coping thickness gives a base width of 14 feet.

When tested by the method given by Trautwine, under the following conditions: Weight of earth backing, 120 pounds per cubic foot; weight of masonry, 140 pounds per cubic foot; natural slope equals angle of wall friction, equals 1 on 1½; gives a factor against overturning of 3.1+, and against sliding of 1.6+, using a coefficient of 0.65, and assuming that the weight of the wall alone resists sliding. The center of pressure falls 0.19 foot inside the outer limit of the middle third.

When checked by the Rankine formula, under the same general conditions, assuming the earth immediately above the back of the stepped wall to resist overturning, the factor against overturning is found to be 3.4, and against sliding 2.2, and the center of pressure falls 0.32 foot inside the outer limit of the middle third. Following the method used in calculating the main lock walls, omitting water pressure, we have the following assumption:

p = horizontal pressure $= \frac{1}{2} wh^2 \cot^2\alpha$.
Weight of earth per cubic foot = 118 pounds.
Weight of masonry per cubic foot = 140 pounds.
ϕ = angle of natural slope = 30°.

$$\alpha = 45^\circ + \frac{\phi}{2} = 60^\circ.$$

These give the following results:

$P=13{,}300$ pounds; weight of triangle of earth resting on back of wall $=13{,}800$ pounds; weight of masonry $=34{,}825$ pounds. The equation of stability is: $34{,}825 \times 5.25 + 13{,}800 \times 11.6 \div 13{,}300 \times 8.67$, which gives a factor against overturning of 2.4. The factor against sliding, using a coefficient of 0.65, is 1.7. The center of pressure falls at the outer limit of the middle third. Under a water pressure of 15 feet—that is, with the water surface behind the wall at reference 22—this wall will have a factor against overturning of 1.85; and against sliding, of 1.13; neglecting the strength of the mortar, and using a coefficient of 0.65 as heretofore. The center of pressure will fall 1.42 outside the outer limit of the middle third.

The section assumed having practically the same factors of safety under the particular conditions assumed for each case as were adopted for the main walls, it is recommended as a safe and proper section for the entrance walls, and the estimates herewith are based on its use. The sketch herewith shows the section in detail.

Specifications.—The following general specifications are suggested:

Materials.—The face stone to be used to be similar in appearance and equal in quality to the stone used in the main lock walls. Backing to be any durable stone. The cement to be either natural or Portland, and to be used in such proportions as to give a mortar equivalent in strength to one composed of 1 Louisville cement to 2 of sand. The face stone to be pointed with Portland cement mortar, mixed 1 to 1.

Workmanship.—The face of the wall is to be rough pointed, with projection not exceeding 1¼ inches below low water, and not exceeding three-fourths inch above low water. The beds and joints are to be one-half inch for 10 inches back from face. Rough backing will be used throughout, all large openings to be filled with concrete. The coping will be tooth-axed and show margin drafts.

General.—Snubbing hooks and ladderways similar to those in main lock will be provided. Six-inch drain pipes will be inserted in the walls every 50 feet at reference 7.0. A dry box drain 30 inches in diameter will be built of stone from the excavation behind the walls at this same elevation, and proper outlets will be provided at the ends. The back filling immediately behind the walls, up to reference 25, to be composed of stone from the excavation, so disposed as to assist in retaining the earth and to prevent the accumulation of water behind the walls. The slopes at ends of the walls to be paved with riprap stone set on edge.

The sketch herewith shows the general dimensions and location of the entrance and the disposition to be made of the surplus earth from the excavation.

In the following estimate the cost of the masonry and similar work has been based on the experience gained in constructing the main lock. For the earth work it has been assumed that it can be done by contract, by parties with proper plant, at the price given. The prices used in estimating the rock excavation are about what similar work has cost us under the same conditions, not including the cost of the plant, which we already have.

Estimate of cost.

2,000 cubic yards solid rock in foundations, at $1.50	$3,000
6,500 cubic yards solid rock in basin, at $1	6,500
5,000 cubic yards solid rock under levee, at $2	10,000
70,000 cubic yards earth inside of levee, at 25 cents	17,500
12,500 cubic yards earth in levee, at 40 cents	5,000
1,000 square yards riprap paving, at $1	1,000
9,100 cubic yards masonry in walls, at $10	91,000
250 cubic yards extra cutting on coping, at $10	2,500
7,000 cubic yards rock backfill, at 50 cents	3,500
10,000 cubic yards earth backfill, at 15 cents	1,500
	141,500
5 per cent for contingencies	6,075
Total ultimate cost	147,570

It is quite probable that considerable stone suitable for backing will be obtained from the rock excavation. All of the stone necessary for the concrete will come from this source.

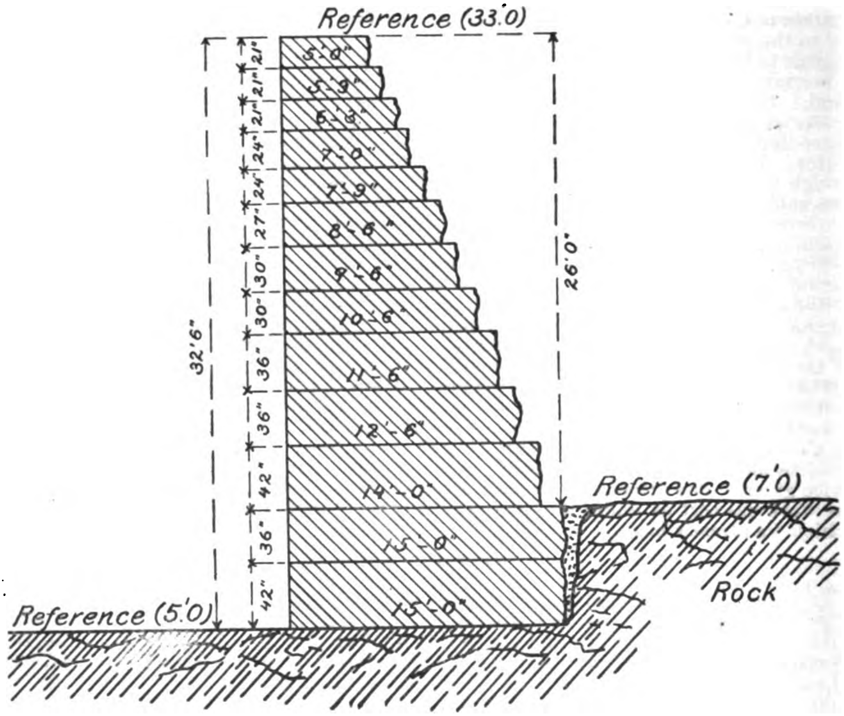
In addition to the necessary plant and appliances we have on hand the following materials available for the work:

822 cubic yards rough sandstone, valued at	$3,626.07
129 cubic yards rough limestone, valued at	297.21
100 cubic yards scabbled sandstone, valued at	400.00
200 cubic yards sand, valued at	300.00
Total	4,623.28

Very respectfully, your obedient servant,

G. T. Nelles, *Assistant Engineer.*

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.



B B 2.

OPERATING AND CARE OF MUSCLE SHOALS CANAL, TENNESSEE RIVER.

The Muscle Shoals Canal has been constructed in accordance with the project approved in 1872 and modified in 1877. It is divided naturally into two parts, locally designated as the upper and lower divisions, the two being separated by 8 miles of river navigation.

The upper, or Elk River section, is a lateral canal which overcomes the Elk River Shoals; it has two locks, with a total lift of 23 feet. It consists of an upper pool, formed by a rock-fill dam, extending from the lower end of Browns Island diagonally across the river and then parallel to the shore to the first lock. Below the first lock is the canal trunk, 1 mile in length, and below the second lock is a dredged channel extending through Gilchrist Chute. The total length of the Elk River division is 5 miles.

The lower division consists of an upper pool, one-half of a mile in length, formed by an extension of the canal embankment above Lock 1, and of eight intermediate pools and nine locks, numbered from 1 to 9, beginning at the upper end. The total length is 14½ miles, and the total lift is 85 feet. The maximum lift of any lock is 13 feet, at Lock 6. The locks are all of the same size. They have a total length of 380 feet, a clear width of 60 feet, and a length between hollow quoins of 300 feet. The culverts are all 4½ by 6 feet. With the exception of Lock A, which may be operated by hydraulic machinery, hand power is used for maneuvering. The average time of lockages is 17 minutes.

Although the canal is naturally divided into two sections, as before described, yet for the purpose of operation, care, and administration it is regarded as a single work.

In March, 1897, this section of the river was visited by a flood of unprecedented height which inflicted a great deal of injury upon the canal. A portion of the damage has been repaired, but some work yet remains to be done. The long masonry wall above Lock A of the upper division was breached in two or three places, but the water has been too high to enable the exact extent of the damage to be determined. When the river falls it is feared that sufficient water will be drawn off through these breaks to so lower the surface as to render the approach to Lock A difficult, if not impossible. These breaks will have to be repaired during the coming low water, but the cost of this work can not be given until a thorough examination can be made. The flood brought an enormous quantity of drift into the pool above Lock A, almost completely filling it. A slight fall in the river caused a large amount of this drift to ground, and it required a great deal of hard work with steamboats and derrick boats to remove it. It was removed, however, in time to prevent any serious delay to steamboats wishing to use the canal.

The high water also threatened the embankments at a number of points along the lower division, and the section between Locks 8 and 9 was overflowed and several hundred feet of the embankment washed away. This, however, was quickly repaired. The great discharge from the small streams flowing into the canal was more than could be taken care of by the ordinary waste weirs. For a short time the water flowed over the top of the lock gates and threatened to cut away the embankments between the locks and the land side. A force was employed day and night to prevent this, and no serious injury resulted.

The expense of caring for a work as extensive as this is and exposed as it is to so many destructive agencies is very much greater than the cost of operation alone. The United States has at this place 11 locks, 1 steel aqueduct, 16 miles of canal trunk and embankment, 30 miles of telephone line, 15 miles of railroad, 1 dry dock, 1 sawmill, 1 machine shop, 1 carpenter shop, 9 lock-masters' houses, 11 assistant lock-masters' houses, and 19 other buildings, quarters, mess halls, storehouses, etc., and 128 acres of land at the locks and along the towpath, besides the dredge, steamboat, derrick boat, naphtha launch, and barges, with tools and appliances. To keep all this in proper repair and to prevent it from deterioration and from destruction involves a considerable annual expense. The canal could be operated for ten times the amount of commerce that at present uses it without greatly increased cost.

In the report of Assistant Engineer Williamson, which is transmitted herewith, a very thorough analysis of the expenditures and costs is given, and special attention is invited to it. From this report it appears that the average cost of operation and care of a lock has been about $70 a month.

Fifteen streams of varying size empty directly into the canal. At every freshet they bring down a certain amount of sediment, and bars are constantly forming opposite the mouths of them. At the entrance of both divisions of the canal also a large amount of silt accumulates at every high water, and constant dredging is therefore required to keep the canal clear. A Bucyrus dredge of the elevator type, having a chain of 24 buckets each of 5 cubic feet capacity, is employed on the canal for this purpose. During the past year 61,550 cubic yards of material has been dredged by this machine at an average cost, including repairs and maintenance of the dredge, of $3 per cubic yard. Of course this very small cost of dredging is due to the fact that the material is discharged upon the bank through a long pipe, and the constant attendance of scows and a towboat is not required.

The sawmill, dry dock, machine shop, and carpenter shop, which have been located at the canal, partly because it was the largest and most important work on the river, and partly because of the water power which existed there, have been of great value, not only in making the necessary repairs upon the canal itself, but also for repairing the fleet employed upon the whole river. The work done at these various shops is described elsewhere in this report and is given in detail in the report of Assistant Engineer Williamson.

The telephone line, 30 miles in length, which extends from Florence, Ala., along the entire canal, crossing the river to reach the upper division, has been of great value, and is a necessary adjunct to the operation and care of the canal. It has been kept in proper repair, the average cost of the maintenance being about $14.50 per mile.

A steam railway of 4 feet gauge extends along the entire length of the towpath of the lower division. With necessary sidings it is 15 miles in length. It is absolutely necessary to the maintenance of the canal, and is very convenient in its operation.

The canal is a lateral one, extending along an unnavigable portion of the river. For a very considerable portion of its length the land side is a rocky bluff, and no road runs parallel to the canal except the railroad. If a break occurs in the embankment of the canal, at least one level is emptied, and the break can not be reached with material for its repair by water. The railroad furnishes the only convenient and possible means of transporting stone, earth, and other material for such repairs to the embankment. The locomotives are also used to assist tows in passing through the canal. The trunk being narrow and crooked, it is extremely difficult for a large tow to pass through with its own power. The rolling stock consists of two 18-ton locomotives, 2 coaches, a small springless open car, 1 wrecking car, and 6 flat cars, besides 2 hand cars and 1 velocipede; an inspection car is being constructed. Necessary repairs have been made to the rolling stock in the shops during the past year. The average number of miles run by the trains is about 2,000 per month, at a cost of about 25 cents per engine mile. The annual cost of maintaining the track has been about $339 per mile. The greatest item of expense is ties, and a very considerable number of new ties will be required during the coming year.

During the next low-water season it will be necessary to paint the iron lock gates and the aqueduct over Shoal Creek; this will slightly increase the ordinary expense of operation and care. The gates, the aqueduct, and the iron work connected with them will all be thoroughly cleaned by a sand blast, which a sufficient trial shows to be very convenient and effective. After much investigation and after consultation with the Chief of the Bureau of Construction and Repair of the Navy Department, it has been decided to paint the iron work with red lead, nothing better or more durable being known for this purpose.

In all cases where work of repair and construction of plant has been done at Muscle Shoals Canal for other sections of the river the cost of this work has been carefully ascertained and charged to the proper appropriations.

Much care has been devoted during the past year to ascertain the unit cost of operating and maintaining the various subdivisions of the canal plant, and it is not thought that they can be reduced below the present point without permitting the plant to deteriorate, thus involving largely increased expenditure in the future. It is worthy of note that the total cost of operation and care of this extensive work, exposed as it is to so many causes of deterioration and injury, is only slightly in excess of 2 per cent of the sum expended in its construction. I think that this will compare very favorably with the cost of maintaining and operating any of the great works on land or water in the country.

Abstract of allotments.

November 28, 1890	$40,000.00
July 1, 1891	31,792.04
July 1, 1892	45,232.90
July 1, 1893	60,975.19
July 1, 1894	63,772.63
July 1, 1895	64,793.11
July 1, 1896	62,707.46
Total	368,273.33

Estimate of funds needed from appropriation for operating and care of canals and other works of navigation (indefinite), to be applied to current expenses in operating the Muscle Shoals Canal, from July 1, 1897, to June 30, 1898.

Amount required for fiscal year ending June 30, 1898		$70,000.00
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities		2,020.45
Additional allotment required for fiscal year ending June 30, 1898		67,979.55
To be expended as follows:		
One assistant engineer at $200 per month	$2,400	
One overseer at $100 per month	1,200	
One overseer of dredging at $85 per month	1,020	
One clerk at $100 per month	1,200	
One machinist at $90 per month	1,080	
Eleven lockmasters at average of $75 per month	9,900	
Eleven assistant lockmasters at average of $35 per month	4,620	
One carpenter at $80 per month	960	
One locomotive engineer at $65 per month	780	
Two stokers at average of $50 per month	1,200	
Forty laborers at average of $25 per month	12,000	
Dredge and towboat crews	9,600	
Subsistence	6,300	
Repair of dredge, plant, material, and contingencies	11,740	
Repairs to dam between Brown's Island and Lock A	2,000	
Cleaning and painting iron gates of eleven locks; also cleaning and painting steel aqueduct	4,000	
Total for year	70,000	

Detailed expenses incurred for operating and care of Muscle Shoals Canal during the fiscal year ending June 30, 1897.

Month.	Office and administration.			Operating, care, repairs, etc., Locks A and B and 1 to 9.				Grand total.
	Salaries.	Supplies.	Total.	Labor.	Subsistence.	Supplies.	Total.	
1896.								
July	$275.00	$2.17	$277.17	$5,433.29	$749.40	$1,306.44	$7,489.18	$7,766.30
August	275.00	2.91	277.91	5,325.80	815.63	1,214.65	7,356.08	7,633.99
September	275.00	1.50	276.50	4,895.83	482.24	919.41	6,297.48	6,573.98
October	248.00	1.25	249.25	4,538.58	669.61	975.69	6,183.88	6,433.13
November	275.00	13.26	288.26	3,466.92	470.04	882.85	4,819.81	5,108.07
December	275.00	6.00	281.00	3,409.70	515.81	308.58	4,234.09	4,515.09
1897.								
January	275.00	3.15	278.15	3,441.98	376.83	265.91	3,779.72	4,057.87
February	275.00	....	275.00	2,650.78	337.14	424.44	3,412.36	3,687.36
March	275.00	.25	275.25	3,251.88	379.59	538.74	4,169.91	4,445.16
April	275.00	....	275.00	3,180.55	294.92	371.20	3,846.67	4,121.67
May	275.00	4.25	279.25	3,261.54	358.97	777.89	4,398.40	4,677.65
June	275.00	3.50	278.50	2,842.40	395.30	442.48	3,680.18	3,958.68
Total	3,273.00	38.24	3,311.24	45,699.25	5,845.48	8,398.26	59,668.31	62,979.55

Abstract of proposals for furnishing one year's supply of fresh meat at Muscle Shoals Canal, opened at United States Engineer Office, Chattanooga, Tenn., at noon, Saturday, February 20, 1897.

No.	Name and address of bidder.	Beef per pound.	Mutton per pound.	Pork per pound.
		Cents.	*Cents.*	*Cents.*
a1	Chas. J. Halter, Florence, Ala.	5½	6	6
2	Price & Blair, Florence, Ala.	7	7	7
3	J. E. Lawler & Co., Florence, Ala.	7½	7	6½
4	Crow & Bros., Florence, Ala.	8	7	7

a Lowest bid; acceptance recommended.

Statement of traffic through the Muscle Shoals Canal during the calendar year ending December 31, 1896, compared with traffic during years ending December 31, 1893, 1894, and 1895.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
Steamers .... number	95	37	85	114	....
Barges .... do	69	30	40	61	....
Rafts .... do	9	27	21	7	....
Miscellaneous craft .... do	35	40	21	11	....
Tonnage .... tons	12,812	5,891	4,578	15,230	....
Lumber .... do	3,543	3,127	1,598	1,049	$6,556.25
Cotton .... do	59	....	....	239	33,370.00
Cotton seed .... do	....	....	....	227	3,405.00
Grain .... do	280	62	178	553	9,318.05
Flour .... do	591	141	500	57	2,850.00
Live stock .... do	....	....	....	9	565.20
Coal .... do	4	295	80	38	76.00
Iron .... do	....	....	195	228	2,280.00
General merchandise .... do	3,119	1,201	1,320	940	84,600.00
Logs .... do	9,049	19,522	1,674	540	2,700.00
Total .... do	16,636	24,348	5,540	3,880	145,720.50
Passengers .... number	3,506	566	254	2,057	....

The above is exclusive of supplies carried by Government steamers.
There was no traffic during the months of August and September.
Number of lockages, 1,040.

REPORT OF MR. SYDNEY B. WILLIAMSON, ASSISTANT ENGINEER.

UNITED STATES MUSCLE SHOALS CANAL, ALABAMA, *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report of operating and care of the United States Muscle Shoals Canal during the fiscal year ending June 30, 1897.

In compliance with your order of October 5, 1896, I transferred the work under my charge at Colbert Shoals to my successor, and reported for duty at Muscle Shoals Canal, the latter having previously been under the supervision of Mr. W. A. McFarland, assistant engineer.

GENERAL DESCRIPTION OF CANAL.

Muscle Shoals Canal has been constructed in accordance with the project approved in 1872 and modified in 1877. The canal is divided into two parts, locally designated as the upper and lower divisions, the two being separated by 8 miles of open river. The former embraces the canalization at Elk River Shoals, consisting of 1.5 miles of canal and two locks. The lower division includes 14.5 miles of canal and nine locks that have been constructed to overcome the obstruction known as Big Muscle Shoals. The average width of both sections is 90 feet. Pertinent to the operation and care of the canal is the operation, maintenance, and improvement of the following property, real estate, and appliances:

United States property and plant at Muscle Shoals Canal.

Character of property.	Amount.
Canal locks	11
Steel aqueduct	1
Canal trunk and embankment ... miles	16
Telephone line ... do	30
Railway (4-foot gauge) ... do	15
Dry dock	1
Sawmill	1
Machine shop	1
Carpenter shop	1
Lock masters' houses	9
Assistant lock masters' houses	11
Quarters, mess halls, and property houses at Lock 6	19
Land at locks and along canal ... acres	128
Bucyrus, dredge	1
Steam flatboat	1
Derrick boat	1
Naphtha launch	1
Barges	6
Tools and appliances ... approximate value	$4,500

Following the classification as given below, a brief description of the plant incident to the operation and care of the canal will accompany the statement of work done during the fiscal year.

Canal: Operation and care of locks; maintenance of embankment; dredging and care of canal trunk.

Railway: Maintenance of way; rolling stock, repairs, etc.; operating.

Telephone line: Operation and repairs.

Machine shop: Operation and repairs.

Sawmill: Operation and repairs.

Buildings: Improvements and repairs.

Floating plant: Operation and repairs.

Dry dock: Operation and repairs.

Quarters and grounds: Care and improvement of.

Miscellaneous.

CANAL.

Operation and care of locks.—The general dimensions of the locks are as follows:

	Feet.
Total length	380
Clear width	60
Length between hollow quoins	300
Average lift	9.75
Maximum lift	12
Culverts	4½ by 6

With the exception of Lock A, which is operated by hydraulic machinery, hand power is used for maneuvering, the average time occupied in making a lockage being seventeen minutes. The valves for the emptying and filling culverts are cast-iron balanced valves, swung on vertical shafts and operated by double-geared winches. The upper gates of Locks 5 to 9, inclusive, are single leaves, extending the full width of the locks; built of vertical I-beams sheathed with wood on the downstream flanges and revolving on horizontal axes located on the miter walls. When open to allow the passage of a boat, they occupy a horizontal position in the plane of the miter-wall coping and are supported upon wooden bents; the latter also support a horizontal shaft, to which are keyed the pinions for maneuvering. In a closed position the leaves incline upstream at an angle of 22° 30′ with the vertical, the water pressure being counteracted by tie-rods to the head wall. Extensive repairs will be necessary during the ensuing year to the bents and operating gear of the above gates. The remaining gates are of the mitering type, having miter angles of 126° 30′. They are constructed of horizontal I-beams sheathed with wrought-iron plates on the upstream flanges and are operated by means of a rack or spar attached to the top frame and a pinion on the lock wall. A lock master and watchman are employed for each lock; the former, however, are skilled mechanics and are employed in the shops or as foremen, leaving the locks in care of the assistants. In addition to operating and caring for the locks each assistant is required to police and improve the United States property in the vicinity of the locks. When necessary for lockages to be made quickly, a crew of laborers is detailed to assist the watchman.

Detailed statement of repairs on locks.

Lock A. Repairing and painting power house; repairing plunger of hydraulic machinery.

Lock B. Made four wooden covers for valve chambers.

Lock 1. Turned up spindle for A-frame.

Lock 2. Repairing walkway on upper gates.

Lock 3. Repairing walkway, valves, and spar platform; renewing miter posts of upper gates.

Lock 4. Repairing valves and spar platform; repointing 1,590 linear feet of joints.

Lock 5. Renewing miter posts of lower gates; repairing walkway.

Lock 6. Repairing walkways, spar platform, and railing.

Lock 7. Repairing spars of upper gates and walkway; renewing miter posts of lower gates; repointing 5,850 linear feet of masonry joints.

Lock 8. Repairing maneuvering gear of upper gate.

Lock 9. Repairing maneuvering gear and tension rods of upper gates, railing and spars on lower gates; making new valve covers.

TABLE A.—*Unit cost of operation and care of locks.*

Month.	Cost per lock for 11 canal locks.	Vessels through canal.		Remarks.
		No.	Cost per vessel.	
1896.				
July	....	34	....	Cost of operation and care of locks not itemized.
August	....	11	....	Do.
September	....	3	....	Do.
October	....	16	....	Do.
November	$61.36	18	$37.50	
December	66.85	42	17.50	
1897.				
January	66.58	61	12.00	
February	56.12	53	11.65	
March	83.32	19	48.23	Excess from additional care incident to flood.
April	54.87	24	25.14	
May	65.87	15	48.30	Including 2 rafts.
June	57.85	14	45.45	
Average	64.10	26	30.72	

Maintenance of embankment.—A large number of small leaks have been repaired during the fiscal year; owing to the fact that said leaks develop suddenly, in the form of cavities from 2 to 4 feet in diameter and extending into the embankment variable distances, it is considered necessary to inspect the entire length of the lower division daily, so that repairs may be made before serious damage occurs. The flood of March, 1897, was without precedent locally, having reached 3 feet above any previous record. The extreme height may be accounted for by the fact that the arrival of the crest of the general flood over the Tennessee River system was accompanied by continuous and severe local rains. The embankment was seriously threatened at various points, and was therefore constantly patrolled by the lock watchman and especial details, in addition to being strengthened at the weak points. The greatest strain resulted from the rapid overflowing of the streams emptying into the canal. For example, on the night of March 19 the water from Second Creek stood 1 foot over the embankment and lock wall at Lock 2, also filling the level below and overflowing Lock 3, causing a slight washout behind the walls of the latter. At the same time Bluewater Creek, aided by a few smaller streams, flooded the pools between Locks 3 and 5. Simultaneously considerable apprehension was caused by the excessive strain on the embankment in the vicinity of Lock 6, from Six Mile Creek, the water being within a few inches of the top of the coping and flowing over the embankment at several points. Immediately below Lock 8 the embankment sloughed off, on the canal side, for a distance of 70 feet; 50 carloads of broken stone were deposited in the breach as soon as possible, and further sloughing prevented. It also became necessary to increase the height of the levee north of Lock 7, to protect the canal from Shoal Creek. Lock 9 and the towpath for 700 feet above were entirely submerged; 200 feet of the submerged embankment washed out 6 feet deep, and the rush of water through the gap raised the drop gate of Lock 9, breaking two of the rods attaching the gate and head wall. All repairs were made without impeding traffic.

Miscellaneous work on embankment.—Extending dry wall below Lock A; clearing off weeds and brush; removing drift and repairing levee south of Lock 6.

Dredging and care of canal.—Fifteen streams varying in size empty into the canal; bars of greater or less extent are constantly forming at the mouth of each. Said bars are removed with the Bucyrus dredge; it is also necessary to dredge at least once during the year at the entrance to both divisions, there being a large accumulation of silt during the high stages. The following dredging has been done during the year:

TABLE B.—*Amount and cost of dredging.*

Month.	Location.	Classification.	Cubic yards.	Cost per unit.	Remarks.
1896.				*Cents.*	
July	Above Lock A	Mud	9,100	2	
August	Vicinity Locks 1, 2, and First Creek.	Mud, gravel, and stone.	12,010	2½	60 cubic yards of gravel and stone.
September	Vicinity of Second Creek.	Mud and clay	10,750	2¾	
October	do	Mud, clay, and gravel.	6,700	4½	200 cubic yards of gravel and stone.
November	do	do	3,150	13½	Numerous repairs to dredge.
December	Cleaning chamber of Lock 1.	Mud			Yardage not measured.
1897.					
January					Dredge laid up.
February					Do.
March	Between Locks 8 and 9.	Riprap and clay	330	19	Embankment washed out by flood.
April	Above Locks A and 1.	Mud	9,225	4¾	
May	Vicinity Locks A, B, and 1.	do	10,000	3¾	
June	Vicinity Locks 1 and 4.	Mud and rock	285	21	
Total			61,550		

In the latter part of February, 1897, a drift jam three-fourths of a mile long was formed at the entrance of the upper division. Immediately upon its formation a slight fall in the river caused portions of the drift to hang on the bottom, and eight days of constant work with a steamboat and derrick boat were required to break up and remove it. The "Parker Gate" was fairly efficient in disposing of the drift after it had been towed within a few hundred feet of the gate.

TABLE C.—*Unit cost of maintenance of canal trunk and embankment.*

Month.	Cost per mile for 16 miles of canal.	Vessels through the canal.		Remarks.
		Number.	Cost per vessel.	
1896.				
July	....	34	....	Cost not itemized.
August	....	11	....	Do.
September	....	8	....	Do.
October	....	16	....	Do.
November	$36.36	18	$32.32	Excess caused by repairs to dredge.
December	8.48	42	3.24	
1897.				
January	9.65	61	2.58	
February	4.87	53	1.49	
March	37.82	19	31.85	Excess caused by repairs incident to flood.
April	46.09	24	30.73	Do.
May	34.95	15	37.28	Including two rafts.
June	10.83	14	12.38	
Average	23.63	26	19.98	

TELEPHONE LINE.

Operation and repairs.—There are 30 miles of telephone line, an instrument being located at each lock. Lock 6 is also connected with the central station at Florence, Ala., thus establishing communication with Florence, Tuscumbia, and Sheffield, Ala. At Lock 1, where the line crosses from the north to the south bank of the river, it was considerably damaged by the recent high water.

Detailed statement of repairs.—Loading, hauling, and distributing 200 new poles; repairing breaks in line between Locks B and 1 and between Lock 9 and Florence; inspecting and making necessary repairs to instruments along line.

TABLE D.—*Cost of operation and maintenance of telephone line.*

Month.	Cost per mile for 30 miles of telephone line.
1896.	
July	$1.78
August	1.50
September	1.58
October	1.58
November	1.17
December	.29
1897.	
January	.16
February	.42
March	.53
April	[a]4.42
May	.78
June	.33
Average	1.21

[a] Excess caused by repairs incident to flood.

RAILWAY.

A narrow-gauge (4-foot) railway extends the entire length of the towpath on the lower division. It is subdivided into sections of a half mile each; the latter are also used for locating leaks in the embankment.

Maintenance of way.—The track is ballasted with broken stone, and is in good condition, as is evinced by the fact that there have been no accidents or derailments. A number of cross-ties require renewing, and it is proposed to still further improve the roadbed in order to reduce the future cost of maintenance to a minimum.

Statement of repairs.—Ballasting, renewing ties, raising and lining track on sections 2, 5, 7, 9, 10, 12, 13, 14, 15, 18, 20, 24, 25, 27, 28, and 30, relaying and ballasting track washed out in the vicinity of Lock 9, repairing switch at Lock 6, extending switch of Lock 1, and laying new side track at sawmill; renewing cross-ties and placing guard rails on Bluewater Bridge and replacing six bents washed from beneath same; repairing track tools and appliances.

Rolling stock.—The rolling stock consists of 2 18-ton locomotives, 1 inspection car, 2 coaches, 1 wrecking car, 6 flat cars, 2 hand cars, and 1 velocipede. An observation car is being constructed.

Repairs to rolling stock.—Repairing laborers' coach and making rods, bolts, and hooks for same; repairing car windows and babbitting boxes for flat car; soldering copper pipe, filing brasses, repairing headlight and grinding valves for locomotives, repairing and painting roof of inspection car, sawing lumber, framing trucks and body, molding boxes, making patterns, rods, plates, bolts, brackets, and turn-buckles, erecting and painting observation car, oiling, greasing, and cleaning coaches.

Operating.—The railway is a most useful adjunct, inasmuch as it provides quick and cheap transportation for men and material, especially in cases of emergency; it also aids materially in passing steamboats with barges through the canal, the custom being to tow the barges with a locomotive. One locomotive is constantly employed in towing barges or transporting men and material, and it is not infrequently the case that both are needed.

TABLE E.—*Unit cost of operation and maintenance of railway.*

Month.	Cost per mile for 15 miles of track.	Miles run by locomotives.		Remarks.
		Number.	Cost per engine.	
1896.				
July	....	....	....	Cost not itemized.
August	....	....	....	Do.
September	....	....	....	Do.
October	....	....	....	Do.
November	$24.12	1,920	$0.18	
December	11.70	1,588	.11	
1897.				
January	23.86	1,327	.26	
February	24.14	1,298	.27	
March	33.03	1,918	.25	
April	38.08	2,182	.26	
May	35.80	1,892	.28	
June	35.83	1,754	.30	
Average	28.25	1,735	.22	

MACHINE SHOPS.

The machine shop is a frame building 56 by 36 feet, located on the south side of the canal, about 500 feet west of Lock 6. The power is derived from a vertical engine having a 7 by 9 inch cylinder and 30-inch driving pulley, the average number of revolutions being 160 per minute. Two air compressors, with 8 by 10 inch cylinders, driven by a turbine, are used as a duplicate power plant. The shops are equipped with the following machinery: 1 lathe having 14-foot bed, 24-inch swing, and cutting from 1 to 36 threads per inch; 1 lathe having 7-foot bed, 12-inch swing, and cutting from 1 to 108 threads per inch; 1 drill press having 16-inch swing; 1 shearing and punching machine; 1 planer 20 inches wide and 4-foot stroke; 1 drill grinder having a 9-inch emery wheel.

Adjacent to the machine shop is a boiler room containing a vertical boiler for supplying the shop engine, and a small pump for filling from the canal a 6,000-gallon water tank from which the locomotives are supplied. Next to the boiler room is the blacksmith shop fitted with a forge and the necessary tools. Statements of the shop work will be found under the classification to which the work is chargeable. Following is a statement of work pertaining to the operation and repairs of the shops that can not properly be charged otherwise:

Made pipe rack, case for pipe fittings, grindstone frame, boxing and bolts for same, set of dies for bolt machine, 5 dividers for shop use, nipple cutters, copper hammer, reamer, water box for blacksmith shop, wrench, punch and dies; turned up shaft and pulley for grindstone; repaired engine, drill press and blower; grinding and repairing drills, lathe tools, reamers, and punching-machine tools. Building stone foundation under lathe and drill press. Oiling and attending machinery.

SAWMILL.

The sawmill was erected and equipped during the last fiscal year, and is described in the Annual Report of 1896, page 2038. In the present year a tram track has been laid into the mill to facilitate handling lumber, the sawdust carrier rearranged so as to deposit sawdust into the tail race. The saw carriage has been strengthened and extended and the shafting modified.

Miscellaneous work of mill.—Made lever straps, spike poles, cant hooks, tram car, tram-track turntable, flooring bits; straps and wheels for extending saw carriage. Repaired roof of mill, log chains, belting, turbine, sawdust chute, friction feed, and tools.

TABLE F.—*Amount and cost of lumber sawed.*

Month.	Sawed.		Planed.	
	Number of feet B. M.	Cost per 1,000 feet B. M.	Number of feet B. M.	Cost per 1,000 feet B. M.
1896.				
July	44,327	$1.98	....	....
August	....	....	....	....
September	21,060	3.20	....	....
October	27,605	3.15	13,461	$1.78
November	30,959	2.56	11,184	1.55
December	34,893	2.78	23,708	1.52
1897.				
January	41,284	2.12	2,827	1.89
February	34,165	1.78	8,935	2.70
March	39,986	1.82	16,842	2.09
April	38,941	1.88	27,794	1.08
May	20,408	3.11	24,859	1.60
June	29,758	2.35	23,995	1.72
Total	359,296	....	153,105	....

Average cost of logs per 1,000 feet, $5.50; average cost of loading and towing, $2; average cost of sawing, $2.17 per 1,000; total cost of sawed lumber, $9.67 per 1,000; average cost of planing, $1.64; total cost of planed lumber $11.31 per 1,000.

BUILDINGS.

The local headquarters is located at Lock 6; it embraces quarters, mess halls, property houses, shops, mill, shelter for animals, locomotive house, tool house, car and lumber sheds, and boat houses. Including the above and the lock houses there are 39 buildings, 24 of which are quarters for employees. All are well-built, carefully finished structures, and are kept in good condition.

Statement of repairs.—Added kitchen and storeroom to assistant engineer's quarters, and closets to lock watchman's house at Lock 6, extending lumber shed, and adding to sawmill. Repairing lockmasters' houses at Locks 1, 3, 6, and 9, painting same at Locks 1, 4, and 5. Repairing lock watchmen's houses at Locks 4, 5, and 6; painting same at Locks 6, 7, and 8. Repairing floor of carpenter shop, doors and blinds of foremen's quarters, laborers' quarters, roof of boiler room and sawmill, also painting the latter. Painting tool and boat houses. Erecting coal shed and shelter for Government animals.

TABLE G.—*Unit cost of repairs and improvements to buildings.*

Month.	Cost per building (39 buildings).
1896.	
July	$5.97
August	....
September	5.05
October	....
November	[a]11.07
December	[a]10.00
1897.	
January	.77
February	.30
March	2.00
April	3.57
May	2.98
June	3.58
Total	45.29

[a] Erecting shelter for Government animals.

FLOATING PLANT.

The following boats are used in connection with the operation and care of the canal:

Steam flatboat	1	Bucyrus dredge	1
Naphtha launch	1	Derrick boat	1
Coal barges	2	Deck barges	4

Steam flatboat.—This is a small flat, 10 by 45 feet, that has been equipped with a boiler and a vertical 5 by 6 inch engine, and is propelled by a stern wheel, connected to the engine shaft by a sprocket chain. It is quite useful for transporting supplies from Florence, Ala., and between the two divisions; also for towing barges in the canal. A second engine, similar to the one in use, is being rebuilt and modified, and will be added to the boat, with a view of increasing the efficiency.

Repairs on flatboat.—Rebuilding engine and fitting same with reverse gear; molding, casting, and finishing brass bushing for cylinders; boring out crossheads, making iron towing knees, 38 feet of sprocket chain, repairing splash bulkhead and painting boat.

Dredge Bucyrus.—The dredge is of the elevator type, having the following general dimensions:

Hull: Length, 80 feet; width, 38 feet, and depth, 6 feet.

Driving engines: 10 by 14 inch cylinders; average number of revolutions per minute, 128.

Swing engines: 8 by 8 inch cylinders.

Buckets: Number, 25; capacity, 5 cubic feet; bucket chain averages a revolution in one and three-fourths minutes.

Discharge pipe: Diameter, 26 inches; length, 60 feet; an extension (15 feet) may be added when necessary.

Boiler: Length, 12 feet; diameter, 60 inches.

Pump for flooding discharge pipe: Steam cylinder, 12 inches; water cylinder, 10 inches; stroke, 18 inches.

Capacity: Depth of cut varies from 3¼ to 10 feet below the water surface; width of cut, 80 feet. Average number of cubic yards per day of eight hours during the past year, —.

Repairs on dredge.—Repairing feed pump, knuckle irons, pinions, head block, crank shaft, bucket ladder, stern spud, hopper, discharge pipe, deck and injector pipe; painted hull and iron work.

Naphtha launch.—The launch is used for making inspection trips, and is fitted with a 4-horsepower naphtha engine. The general dimensions are: Length, 25 feet; beam, 5 feet; draft, 24 inches. The engine has been generally overhauled during the year and a new propeller fitted to the shaft.

Derrick boat and barges.—These are of ordinary construction, and are of general use in maintaining the canal.

Repairs to derrick boat.—Putting on spuds and casing; repairing cabin, derrick, and smokestack.

Repairs to barges.—Painting, calking, and other minor repairs.

Repairs to U. S. S. Colbert.—Repairing wheel, gauge cock, roof, and hull; made rudder irons, bolts, patterns for furnace linings, towing straps, cylinder rings and frames for remodeling hull; planing and drilling cam frames.

DRY DOCK.

The dry dock was completed in February, 1897, and is located on the north side of the canal, 600 feet west of Lock 6. The general dimensions are: Length, 175 feet; width, 60 feet; total depth, 7 feet. The foundation is solid rock, the bottom having been formed by filling the irregularities and giving the necessary crown for drainage, with chert well rammed into place. The sides are built on an angle of about 45 degrees by laying at this angle an inclined wall piece, supported by mud sills and secured to a longitudinal timber bolted to the rock at the foot of the slope. The altars are bolted to the wall pieces so as to insure a 2-inch water-tight joint. The entrance to the dock is closed by a wooden drop gate 40 feet long, supported by masonry abutments. Since its completion the dock has been constantly occupied, the following boats having been docked and repaired: Steamer *S. H. Long*, dredge *Harwood*, 3 derrick boats, 2 quarter boats, and 4 barges. Details of the repairs on the above boats will be found in the report of work done at Muscle Shoals Canal under the appropriation for improving the Tennessee River.

Work done in constructing dry dock.—Excavated 193 cubic yards of earth and 649 of solid rock, filling 127 cubic yards of earth behind abutments; drilling, blasting, and bull painting bottom, grading side slopes, sawing, framing, and erecting 34,500 feet B. M. in side walls; loading, depositing, and ramming chert in bottom; erecting drop gate, putting in gate valves, making eyebolts for keel blocks, and excavating emptying culverts.

QUARTERS AND GROUNDS.

The United States owns, approximately, 128 acres of land, including the towpath and reservations at the various lock sites. Said land is being improved each year, the method being to first clear it of underbrush and ditch such portions as require drainage, and, finally, to make such improvements as seem suitable by grading, sowing grass, planting trees, building walks and roads, or otherwise.

Statement of work.—Grading at Locks 2, 4, 5, 6, and 7; ditching at Locks B and 6 and in the vicinity of Four Mile Creek; grading, and sowing grass at Locks A and B; sowing grass at Locks 4 and 9; fencing at Locks A and 6; repairing roads and walks, pump at spring; building stone arch culvert at Lock 6; cleaning and caring for quarters. Average cost per month for improving and caring for quarters and grounds is $2.08 per acre.

MISCELLANEOUS.

Delays to boats.—The steamer *Luke Prior, jr.*, was delayed at the upper division for about five hours, when the entrance of the canal was filled with drift; otherwise the canal has been constantly open for traffic.

There have been no accidents or injuries of moment to either the plant or employees.

Subsistence.—The average cost of subsistence per man per month has been $6.44.

Forage.—The average cost of forage has been per animal per month $4.54.

Miscellaneous work.—Caring for Government animals; hauling provisions and supplies; repairing wagon, stove, brush hooks, derrick, skiff, water tank, and range; cutting wood for kitchen; towing logs and material; loading and unloading coal; storing ice; surveying United States property of Locks 2, 5, and 6; making plugs for telephone; sharpening and repairing tools.

Cost of operation and care of Muscle Shoals Canal.—The unit costs of operating and maintaining the various subdivisions of the canal plant have been given in the preceding tables. It would also seem well to call attention to the fact that the total annual cost of operation and maintenance is very slightly in excess of 2 per cent of the total sum expended on construction.

Very respectfully, your obedient servant,

Sydney B. Williamson,
Assistant Engineer.

Capt. Dan C. Kingman,
Corps of Engineers, U. S. A.

B B 3.

IMPROVEMENT OF FRENCH BROAD RIVER AND LITTLE PIGEON RIVER, TENNESSEE.

The French Broad River is one of the largest tributaries of the Tennessee. The stream has its source in North Carolina on the western slope of the Blue Ridge, enters the State of Tennessee at Paint Rock, and after a course of 121 miles unites with the Holston River 4½ miles above Knoxville, thus forming the Tennessee River.

An appropriation was made by the State of Tennessee about 1840 for the purpose of improving the rivers of the section then known as the "East Tennessee District," and the improvement of Seven Islands Shoals of the French Broad River, about 30 miles below Dandridge, was begun under direction of commissioners appointed by that State. The State of Tennessee also built some dams above Dandridge, but these, with the exception of a few repaired by the United States in 1881, have been removed during the progress of the work under the present project.

An examination was made of the French Broad in Tennessee under authority of act of Congress July 11, 1870, and the report upon it is to be found in the Report of Chief of Engineers for 1871, pages 491–494. A reexamination in Tennessee was ordered by Congress in act of March 3, 1875, "from its junction with the Holston at Knoxville to Leadvale, Tenn." The estimate made in 1871 was resubmitted with the report of 1876.

Below Leadvale, mouth of Nolichucky River, a distance of 90 miles, the river is impeded by the surface obstructions usually found in mountain streams. This stretch of river is exceptionally beautiful, broad, and adapted to navigation, especially below Dandridge about 50 miles. The fall being only about 1 foot per mile, the channel can be easily improved. From the junction of the Nolichucky River to the Tennessee State line, 31 miles, the French Broad is not susceptible of improvement except by slack-water navigation, the fall being 7 feet per mile.

The present project of improving the channel from mouth of river to Leadvale, about 90 miles, consists in removing surface obstructions, cutting down overhanging trees, and building wing dams where necessary, so as to permit the passage of boats drawing 2½ feet during the ordinary low-water season. Under this plan operations have been carried on at the most serious obstructions.

The following appropriations have been made by Congress for improving French Broad River in Tennessee, viz:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$10,000
March 3, 1881	3,500	July 13, 1892	15,000
August 2, 1882	5,000	August 14, 1894	7,000
July 5, 1884	3,500	June 3, 1896	5,000
August 5, 1886	6,000		
August 11, 1888	10,000	Total	75,000

The total amount expended to the close of the fiscal year ending June 30, 1896, including outstanding indebtedness, was $67,351.33.

This expenditure has resulted in the improvement of ten of the principal obstructions below Dandridge by deepening and clearing the channel, removing fish traps, constructing and modifying wing dams, and revetting the banks when necessary. A list of these ten obstructions, with their distances below Dandridge and the work done at each to June 30, 1890, is given in the Annual Report of the Chief of Engineers, 1891, pages 2262, 2263.

The improvements which yet remain to be made are generally of a class which can not be economically and advantageously executed without the possession of a very considerable plant. A towboat and barges are necessary to move stone for the construction of dams and the protection of banks. Derrick boats are necessary for the removal of snags and bowlders from the channel, and a drill raft with steam drills is needed for breaking up the reefs. Quarterboats are also necessary to conveniently take care of the laboring force. None of these things belong to the French Broad River, and the appropriations have always been too small to permit of their purchase. For this reason no work was done on the river during the past season.

This year it is intended to take the plant belonging to the Upper Tennessee River and use it for two or three months on the French Broad. In this way the amount available can be most economically and advantageously applied and more and better work done for the money than in any other way. It is difficult to fully describe the work that it is proposed to do. At Hanging Rock Shoals some extension of the training wall will be necessary, and a portion of the caving bank will be revetted; at two or three other places where improvements have been made bank protection is much required, and a great many reefs and bowlders, small in themselves, but exceedingly detrimental to low-water navigation, will be removed by the fleet. It is hoped to do work of this kind over the river as far up as Dandridge, 50 miles from the mouth.

No survey of the river has ever been made, and it is therefore very difficult to prepare detailed plans for its improvement. The total amount necessary to make the improvement, which even at the time was not fully described, was simply a guess based upon a reconnoissance.

I am of the opinion that it will not be sufficient to complete all the work that must be done to carry out the improvement to the extent proposed.

The total amount of money available for improving this river will be expended before the close of the fiscal year.

The amount expended during the fiscal year ending June 30, 1897, including outstanding indebtedness, was $253.96.

The improvement of the French Broad River, Tennessee, is of importance to the inhabitants along its banks, not only by reason of its increasing commerce, but because of its being constantly used as a highway for travel by the people themselves, a large number of passengers being carried by the small steamers that ply upon this stream. The commerce consists principally of marble, sand, logs, lumber, forage, grain, live stock, wood, and general merchandise. The completion of the existing project of improvement will materially aid in the development of the mines, and will open a river highway for the transportation of the mineral wealth of the mountains and the products of the rich agricultural lands of the region drained by the river and its tributaries.

LITTLE PIGEON RIVER, TENNESSEE.

This stream is formed by the junction of its east and south forks at Sevierville, Tenn., and flowing northwesterly for about 5 miles it enters the French Broad River about 32 miles above Knoxville.

An examination of Little Pigeon River was made under the provisions of river and harbor act of September 19, 1890. The channel was found to be obstructed by rock reefs and gravel shoals, the object of the proposed improvement at the estimate of cost submitted ($10,000) being to open up the river to navigation as far as Catlettsburg, about 2 miles, permitting the passage of the small steamers that ply upon the French Broad River, and occasionally during extreme high water to ascend to Sevierville, 5 miles from the mouth of the river. (See report printed as House Ex. Doc. No. 159, Fifty-first Congress, second session, and Report of Chief of Engineers, 1891, pp. 2287–2288.)

The river and harbor act of July 13, 1892, provided that of the $15,000 appropriated for improving French Broad River, Tennessee, $1,000 "may be used in removing bar or shoal in Little Pigeon River." This sum was allotted for the removal of the bar near the mouth of the river, described as the only bad shoal below Catlettsburg. No work was done nor expenditures made during the fiscal year ending June 30, 1896.

The floating plant belonging to the Tennessee River while it is employed on the French Broad River will also be utilized in carrying on the work proposed at or near the mouth of the Little Pigeon River as far as the funds available will allow.

The total amount expended to close of fiscal year ending June 30, 1896, was $69,517.95.

Money statements.

FRENCH BROAD RIVER.

July 1, 1896, balance unexpended	$5,517.44
June 30, 1897, amount expended during fiscal year	122.73
July 1, 1897, balance unexpended	5,394.71
July 1, 1897, outstanding liabilities	131.23
July 1, 1897, balance available	5,263.48
Amount (estimated) required for completion of existing project	77,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

LITTLE PIGEON RIVER.

July 1, 1896, balance unexpended	$849.61
July 1, 1897, balance unexpended	849.61
Amount (estimated) required for completion of existing project	8,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	8,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Commercial statistics of French Broad River, Tennessee.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Grain	8,600	28,933	9,814	17,780	$333,000
Lumber	2,200	5,733	7,414	16,260	101,625
Flour	300	733	506	5,028	251,400
Live stock	580	453	480	4,000	160,000
Wood	150		400	12,150	8,275
General merchandise	5,595	13,546	10,311	3,060	275,400
Iron ore			66		
Hoop poles			12	2,900	1,900
Coal			566	2,000	4,000
Hay			1,150	3,750	45,000
Logs			7,041	83,838	135,735
Shingles			5,000	30	1,000
Brick			138	1,063	3,300
Sand				77,400	14,000
Tan bark				2,000	8,500
Railroad ties				2,920	6,200
Tobacco				225	21,500
Fertilizer				500	24,000
Produce				800	32,000
Marble				12,000	40,000
Telephone poles				1,500	3,000
Total	17,425	49,398	42,898	249,204	1,469,835

Number of passengers transported (1896), 21,200.

List of steamboats (stern-wheel) plying on the French Broad River, Tennessee.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Telephone and 6 barges	93	19	2.6	97.47	168
Lucile Borden and 6 barges	86	14	2.5	55.32	168
C. M. Fouche	96	14	3	61.12	
Onega and 1 barge	104.06	18	2.5	74.77	28
Oliver King	60	8	2.6	29.30	
Flora Swan and 7 barges	98	13	2.8	57.81	210

In all, 6 steamboats of 375.79 tons burden net, and 20 barges of 574 tons capacity.

B B 4.

IMPROVEMENT OF CLINCH RIVER, TENNESSEE.

The Clinch River rises in the Cumberland Mountains, in southwestern Virginia, and flows in a southwesterly direction, generally parallel to the Holston River, and empties into the Tennessee River at Kingston, Tenn., 104 miles above Chattanooga and 79 miles below Knoxville, the length of its course in Tennessee being about 230 miles.

Between 1830 and 1845 work was done by the State of Tennessee, but it resulted in little or no advantage to navigation. The country drained by this river, about 4,500 square miles, is mountainous and has very meager transportation facilities.

Under authority of act of Congress approved March 3, 1875, examination of the river was made both in Virginia and Tennessee. Osborn Ford, Virginia, about 35 miles northeast of the Tennessee line, is regarded as the head of high-water navigation on the Clinch River. It has no low-water navigation. (See Report of Chief of Engineers, 1876, pp. 736–747.) An examination of the Clinch River from Nash Ford, Virginia, to Haynes (or Walker Ferry), Tenn., a distance of about 161 miles, was made in 1880. (See Report of Chief of Engineers, 1881, pp. 1864–1867.) The original project, submitted in 1876, provided only "to improve the high-water navigation of this river, so that there shall be less difficulty and danger in bringing out cargoes, and so that rain tides of 3 or 4 feet may be made use of for boating purposes." This was estimated at $26,400. In 1881 the engineer officer in charge reported that he hoped to attain a permanent increase of depth of water in channel by blasting rock, etc., "securing for about 146 miles of the lower river at ordinary low water, from its mouth to Clinton, about 2 feet, and from Clinton to Walker Ferry (Haynes) about 1½ feet," adopting the low-water channel, which in 1876 had been simply suggested as a channel that might be found practicable after a careful survey, and thus modifying the then existing project, but without increasing the original estimate, which was simply for high-water navigation, by the cost of the channel projected. In 1885 the estimate was increased to $50,000, "because it had been found necessary to make the channel from two to three times the width thought sufficient when the original estimates were made," but the estimate was not increased, although the proposed low-water navigation instead of the high-water navigation was adopted as part of the present project; therefore the balance of the original estimate as modified and remaining unappropriated, $8,500, is manifestly inadequate to complete the work as projected.

The examinations made of the Clinch River are not sufficient whereon to base an estimate of the cost of the projected low-water channel below Walker Ferry, but if radical improvement is to be undertaken it is recommended that a detailed survey be made to obtain the data necessary to determine the cost, having in view an advantageous and economical prosecution of the work.

Above Walker Ferry to the Tennessee State line, about 85 miles, the only projected improvement is to reduce the ledges and remove loose rock, etc., sufficiently to assist flatboat navigation and rafting during "rain tides."

The following appropriations have been made for this improvement:

Act of—		Act of—	
June 14, 1880	$10,000	September 19, 1890	$4,000
March 3, 1881	3,000	July 13, 1892	4,000
August 2, 1882	3,000	August 17, 1894	2,500
July 5, 1884	5,000		
August 5, 1886	5,000	Total	41,500
August 11, 1888	5,000		

The total amount expended to June 30, 1896, including outstanding indebtedness, was $37,119.20; the general results attained by this expenditure are that the reefs have been reduced, many snags and overhanging trees removed, and several strong heavy wing and longitudinal dams built, thus securing a passable channel at stages of the water 2 or 3 feet lower than before the improvement was begun.

Above Haynes (or Walker Ferry) special advantages were secured about ten years ago at Hunter Shoals, Sycamore Shoals, Hopson Shoals, and Straight Shoals.

Below Walker Ferry (Haynes) important work has been done at Black Shoals and Bletcher Shoals; at Cloud Shoals seven dams have been built and a heavy dam at Hibb Shoals, which, with the rock excavation in channel, have lessened the dangers to navigation. At Llewellyn Shoals the improvements completed consist of reducing projecting rocky points, removing snags, sand, and gravel from the channel, completing wing dams, and constructing dam 190 feet long about 324 feet below Moore Ferry or Ford. Safe navigation at these shoals is now reported possible at a stage of water from 1 to 1½ feet lower than before the work done in 1892 was begun. At Young Island the fish-trap dam was taken from the chute south of the island, but more work is necessary to confine the water to one channel for the floating of logs to the mills below the island.

In July, 1892, partial examinations were made below the mouth of Powell River, and in October below the mouth of Emory River, having in view the ascertaining, in a general way, of what work is necessary to be done to improve the channel to the extent of securing a navigable depth of 2 feet at ordinary low water.

It is thus seen that no survey has ever been made and no detailed plans for its improvement have ever been prepared. The estimates of the amount necessary to improve it were simply based upon rapid reconnaissances made a good many years ago. It is evident that the amount estimated was not sufficient for the work proposed.

The low-water navigation of the Clinch River amounts to nothing at present; all the business that has been done upon it is at high or intermediate stages. The principal commodity carried consists of logs made up into rafts.

The funds now available amount to a little over $4,000, and it is believed that the greatest benefit to the commerce of the river will result from applying this sum to its improvement with reference to the stages at which it is navigable. A project has therefore been prepared and approved for the expenditure of this sum in removing snags, bowlders, overhanging trees, reefs, or other obstructions, so far as practicable, from Osborn Ford, the head of navigation, downward to the mouth. The work to be done is to be such as will tend to render navigation safer and easier for steamboats, flatboats, and rafts at the stages at which the river is now used.

A party will be assembled at Osborn Ford and work downward over the river during the present low-water season. This party will be provided with small flatboats for the transporation of men and supplies, and with tents for camping on the shore. It will be accompanied by a competent raft pilot, thoroughly familiar with the navigation of the river, who will point out the places that most need improvement. It is believed that in this way the greatest good will be secured to the navigation interests of the river, which the commercial statistics given herewith show to be valuable and important.

Money statement.

July 1, 1896, balance unexpended	$4,380.80
June 30, 1897, amount expended during fiscal year	34.00
July 1, 1897, balance unexpended	4,346.80
July 1, 1897, outstanding liabilities	28.84
July 1, 1897, balance available	4,317.96
Amount (estimated) required for completion of existing project	8,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	8,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Commercial statistics of Clinch River, Tennessee.

Articles.	Year ending December 31—				Estimated value, 1896.
	1893.	1894.	1895.	1896.	
	Tons.	*Tons.*	*Tons.*	*Tons.*	
Grain	94	1,290	1,276	5,152	$67,311
Flour	10	110	71	95	4,750
Iron ore	5	44	766	....	....
Lumber	160	201	1,844	2,376	14,564
Live stock	....	80	1	32	1,701
General merchandise	339	11,207	840	1,386	122,185
Logs	....	....	61,473	23,860	119,600
Cotton	....	....	13	....	....
Coal	....	....	466	2,800	2,800
Hay	....	....	2,150	665	8,548
Brick	....	....	....	170	1,300
Staves	....	....	....	50	138
Tan bark	....	....	....	40	2,400
Railroad ties	....	....	....	1,485	5,198
Produce	....	....	....	145	6,488
Sand	....	....	....	1,200	800
Total	608	12,932	68,900	39,456	357,783

Number of passengers transported (1896), 2,634.

List of steamboats (stern-wheel) plying on the Clinch River, Tennessee.

Name.	Length.	Breadth.	Depth.	Net tonnage.	Capacity of barges.
	Feet.	*Feet.*	*Feet.*		*Tons.*
Kingston and 3 barges	55	11	3	37.80	145
Tallassee	60	12	2	22.16	....
Lora	70	12	2.5	22.16	....
Maud and 4 barges	79	16.5	3.2	23.30	800
J. C. Warner and 2 barges	142	31.6	4.6	201.05	300
J. P. Kindrick and 2 barges	112	20	3.7	125.71	300
E. P. Dawson and 4 barges	60	10	2.8	29.30	157.20
Key City and 1 barge	80	15	3.2	59.45	45
Clinton B. Fisk and 2 barges	100	18	3.4	78.89	164.60

In all, 9 steamboats of 599.82 tons burden net, and 18 barges of 1,911.80 tons capacity.

B B 5.

SURVEY OF MOUTH OF TENNESSEE RIVER, KENTUCKY.

[Printed in House Doc. No. 19, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 7, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated March 20, 1897, with two maps,* by Capt. Dan C. Kingman, Corps of Engineers, giving the results of a survey of the mouth of the Tennessee River, made in compliance with the provisions of the river and harbor act of June 3, 1896.

The existing project for the improvement of the mouth of the Tennessee River provides for the preservation of Livingston Point by means of bank protection and the construction of pile and stone dikes.

Captain Kingman states that this portion of the river is in good condition, having sufficient depth for all purposes of navigation, and that steamboats can enter and leave it without difficulty. There appears to be no necessity for work of protection or improvement at the mouth, so far as the interests of navigation are concerned, but the maintenance of Livingston Point is desirable and necessary in order to preserve the harbor of Paducah. This point is protected on both sides by a riprapping of stone, and, in the opinion of Captain Kingman, it would perhaps be desirable to add to and strengthen the work throughout. There is available for this purpose about $19,000, which will be sufficient for some time to come, and arrangements have already been made to place a large amount of stone on the revetment.

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* Not reprinted. Printed in House Doc. No. 19, Fifty-fifth Congress, first session.

The local officer expresses the opinion that no further appropriation or allotment is necessary at this time for the mouth of the river, and his views are concurred in by the Division Engineer, Col. J. W. Barlow, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., March 20, 1897.

GENERAL: By direction of the Secretary of War and in compliance with the provisions of section 9 of the river and harbor act of June 3, 1896, I have the honor to submit the following report upon the survey of the mouth of the Tennessee River, Kentucky:

In December, 1895, a survey was made in connection with the improvement of Livingston Point, Kentucky. This survey necessarily included the mouth of the Tennessee River. In November, 1896, the general survey of the river below Riverton was extended down to the mouth. The results of these two surveys are shown upon tracings which are transmitted herewith. These tracings are not made to the same scale, and the survey of 1895 shows the river at a 3-foot stage; that of 1896 has the soundings and water surface reduced to extreme low water. A comparison of these two charts shows that there has been no change in this vicinity in the past year. They both show that the mouth of the Tennessee River is in a good condition and has sufficient depth for all purposes of navigation, and that steamboats can enter it and leave it without difficulty.

There appears to be no necessity of any work for the protection or improvement of the mouth of the Tennessee River so far as the interests of navigation are concerned. The maintenance of Livingston Point is desirable and necessary in order to preserve the harbor of Paducah. If Livingston Point should break away, the Tennessee River might unite with the Ohio above the island, and finally a bar might connect the island with the shore and in this way destroy the harbor of Paducah. Livingston Point is protected on both sides by a riprapping of stone. This, though generally in pretty good condition, is in need of repair at some places, and it would perhaps be desirable to add to it and strengthen it throughout. There is on hand and available for this purpose a little over $19,000. This, in my opinion, would be sufficient for some time to come.

Arrangements were made a few weeks ago to place a large amount of stone upon this revetment, but the very high stage of the river, which has completely submerged the point, has caused these operations to be deferred until the river falls.

I do not think that any further appropriation or allotment is necessary at this time for the mouth of the Tennessee River.

Very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
St. Louis, Mo., March 30, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the views of Captain Kingman.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

B B 6.

SURVEY OF EMORY RIVER, TENNESSEE, FROM ITS MOUTH TO THE TOWN OF HARRIMAN.

[Printed in House Doc. No. 22, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 8, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated March 18, 1897, by Capt. Dan C. Kingman, Corps of Engineers, upon the results of a survey of Emory River, Tennessee, from its mouth to the town of Harriman, made to comply with the provisions of the river and harbor act of June 3, 1896.

This river is situated wholly in the State of Tennessee, flowing in an easterly direction, and emptying into the Clinch River about 4 miles from the mouth of the latter. The Clinch River in turn empties into the Tennessee River at the town of Kingston.

Captain Kingman is of the opinion that an improvement to secure low-water navigation in the Emory would be valueless unless it was extended to the mouth of the Clinch, and that the improvement of these streams with a view to obtaining open-channel navigation is impracticable.

The plan of improvement proposed in the report contemplates the construction at Kingston of a lock and a dam, the latter to be provided with four bear-trap sluices to be placed next to the lock and to serve as the movable portion of the dam. The total cost of the proposed work is estimated at $260,000. It is stated by the local officer that the method of improvement thus outlined would afford not only a perfect low-water navigation to Harriman on the Emory, but would at the same time effect an improvement on the Clinch by backing up the water for a probable distance of 20 or 25 miles, and in his opinion the river is worthy of improvement in accordance with the plans proposed.

In transmitting the paper to this office the division engineer, Col. J. W. Barlow, Corps of Engineers, reported as follows:

> This improvement would doubtless be of value to the town of Harriman, but as the Tennessee River, to which the Emory is tributary, is navigable only during medium and high stages, it seems questionable if so great an expenditure as must be involved in the construction and maintenance of a lock and dam should be undertaken at the present time, and I would therefore recommend that the construction of a lock and dam, though a worthy improvement, be deferred until after the contemplated improvement for obtaining constant navigation in the Tennessee River be completed.
>
> The benefit to the Clinch River by locating a lock and dam at Kingston will be inappreciable unless supplemented by continuing the system above at enormous expense.

The views and recommendation of Colonel Barlow are concurred in by me.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

ENGINEER OFFICE, UNITED STATES ARMY,
Chattanooga, Tenn., March 18, 1897.

GENERAL: In obedience to the direction of the Secretary of War and in compliance with the provisions of section 9 of the river and harbor act of June 3, 1896, I have the honor to submit herewith the results of the survey of the Emory River, in Tennessee, from its mouth to the town of Harriman.

The Emory River is situated wholly in the State of Tennessee; it flows in an easterly direction and empties into the Clinch River about 4 miles from its mouth; the Clinch River in turn empties into the Tennessee River at the town of Kingston, about 104 miles above Chattanooga.

The results of the survey are set forth upon the accompanying charts,* and to these charts have been added copies of the survey made by Lieut. John Biddle, Corps of Engineers, of the Clinch River from the mouth of the Emory to the Tennessee. The survey shows that the Emory River is confined between high banks; that it has a width sufficient for all purposes of navigation; that, as is the case with all rivers of this kind, it is made up of a series of deep pools separated by reefs or bars. This is clearly shown upon the accompanying longitudinal profile. The profile, of course, is very much distorted. If the horizontal scale was the same as the vertical scale, the length of the profile would be 200 yards.

The obstructions to the navigation of the Emory River, aside from a few snags which could easily be removed, are the bars, upon which at low water there is probably not much more than a foot of navigable water. The discharge of the Emory River was measured at about a 2-foot stage, which corresponds as near as may be to the normal stage of the river. It amounts to 290 cubic feet per second. This discharge is altogether too small to permit the river to be improved by dredging or by the construction of wing dams or training walls. The former method would simply lower the surface of the water, and the latter would accelerate the current without greatly increasing the depth.

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*Not printed.

The distance from the mouth of the Emory to the town of Harriman is about 12 miles, and from the mouth of the Clinch to the mouth of the Emory the distance is about 4 miles, making the total distance from Harriman to the Tennessee River 16 miles. As will be shown from the longitudinal section and from the accompanying charts of the Clinch River, the navigation in it at low water is as bad or even worse than it is in the Emory. An improvement which should secure low-water navigation in the Emory would be valueless unless it was extended to the mouth of the Clinch. The normal condition of both these rivers is a low stage. The high water which results from rainfall comes quickly and quickly subsides. These freshets are locally known as "tides;" advantage is taken of them to transport lumber in rafts and to make occasional trips with steamboats, but they are of such irregular occurrence and short duration that no reliable system of navigation is at present possible on either of these rivers. The fall at low water from what is known as the "Steamboat Landing" in Harriman to the mouth of the Clinch is a little less than 11 feet; the discharge of the Clinch River is not known, but from its size and length it must considerably exceed that of the Emory.

A very simple and complete improvement of the Emory River is possible by the construction of a dam at Kingston, on the Clinch, this dam to be capable of raising the surface of low water 12 feet. A proper location of the dam would be at or near the point marked "Upper Landing," at Kingston. The bottom of the river, as shown by borings at this place, is of solid limestone rock. From this point down to the mouth of the river the depth is sufficient at all times for all purposes of navigation. The width of the river at this point is about 700 feet. I would recommend the construction of a lock near the right bank of the river where the water is deepest, the height of the lock walls being such as to permit the operation of the lock until the water attains a stage about 12 feet higher than the top of the dam. The lock should be of the same size as those in the Muscle Shoals Canal—that is to say, 60 feet wide and 300 feet long. It should be connected with the right bank by a dam having a height equal to that of the lock walls. Next to the lock should be placed four "bear-trap" sluices, each 50 feet long; these would constitute the movable portion of the dam. The remainder of the dam should be made solid and permanent, having its crest at a height of 12 feet above low water. On a rise of the river one or more of the bear-trap gates could be lowered to keep the pool at its normal level. On a further rise all the sluiceways could be lowered or opened, and thus occasion a more speedy backing out of the dam; the lock could be used until a sufficient depth existed over the 400-foot fixed dam, when all navigation could be over this. A reverse operation as the discharge of the river diminishes would put the lock in operation and keep the pool at its proper height.

I estimate that the fixed dam would cost about $80 a linear foot, or $32,000 in all; the bear-trap sluice about $275 a linear foot, or $55,000 in all. The lock, for which no excavation would be necessary, would cost about $150,000. To this should be added about 10 per cent, or $23,000, for contingencies; making the total cost of the improvement $260,000.

This improvement would have the advantage not only of giving a perfect low-water navigation to Harriman on the Emory River, but would at the same time effect an improvement on the Clinch River by backing up the water for a distance probably of 20 or 25 miles.

It is impossible to obtain exact statistics of the commerce which would be benefited by the proposed improvement. Since the Emory River has not been under improvement heretofore, no separate record of its commerce has been kept; it has simply been included with that of the Clinch. In the year 1895 about 69,000 tons of freight was transported on the Clinch River system; the value of this was about $440,000. I can not say what portion of this belonged to the Emory River, but all of it would be benefited by the plan of improvement which has been proposed. No doubt a very considerable commerce would be developed as a result of this improvement.

In order to determine or at least to form some idea what this would be, I addressed a communication to Mr. Walter C. Harriman, of Harriman, Tenn., and in response to my request he has submitted a number of letters bearing upon this subject. These letters are transmitted herewith. They are: A letter of G. W. Chandler, general manager of the Harriman and Northeastern Railroad Company, who writes particularly in regard to the agricultural interests; J. D. Robert, who writes in regard to the iron interests; J. T. Hill, general manager of the Brushy Mountain Coal Mines, who writes in regard to the coal interests; George B. Durell, president of the Harriman Hoe and Tool Company, who writes in regard to the manufacturing and timber interests; Walter C. Harriman, who writes in regard to the present navigation on the river; S. W. Williams, secretary Business Men's League, who writes in regard to the general interests of the town of Harriman; J. W. Scott, who writes in regard to the quality and quantity of coal naturally tributary to this river, stating that the supply is inexhaustible.

In view of the foregoing, I am of the opinion that this river is worthy of improvement in accordance with the plans which I have outlined.

Very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, SOUTHWEST DIVISION,
St. Louis, March 31, 1897.

Respectfully forwarded to the Chief of Engineers, U. S. A.

This improvement would doubtless be of value to the town of Harriman, but as the Tennessee River, to which the Emory is tributary, is navigable only during medium and high stages, it seems questionable if so great an expenditure as must be involved in the construction and maintenance of a lock and dam should be undertaken at the present time, and I would therefore recommend that the construction of a lock and dam, though a worthy improvement, be deferred until after the contemplated improvement for obtaining constant navigation in the Tennessee River be completed.

The benefit to the Clinch River by locating a lock and dam at Kingston will be inappreciable unless supplemented by continuing the system above at enormous expense.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

LETTER OF GENERAL MANAGER, HARRIMAN AND NORTHEASTERN RAILROAD COMPANY.

HARRIMAN AND NORTHEASTERN RAILROAD COMPANY,
OFFICE OF GENERAL MANAGER,
Harriman, Tenn., February 26, 1897.

GENTLEMEN: Noting that the city of Harriman, through yourselves, is looking, as far as possible, to have laid before the Government authorities the importance of the contemplated improvement of the Emory River, thereby to make same navigable to the city of Harriman during the whole year, as a party of interest and a representative of the Harriman and Northeastern Railroad, I would most earnestly add my influence in trying to show up the importance of said improvement as second to none, considering the cost of same to the interest it will affect.

To make such improvements would open an avenue of transportation beyond our present conception in relation to the many interests it would affect. First, the farming interest bordering the Clinch, Tennessee, and Emory rivers would greatly appreciate the said improvement as a means of reaching transportation in many directions from Harriman as a central railroad point, as well as appreciating the supply or consumption of said city. The quantities of corn and hay now shipped at incidental tides but foreshadow how a constant means of transportation would be appreciated. The wood-working factories of Harriman would be placed in close reach of great quantities of raw materials along the banks of said river, not now navigable, excepting a few months in the year, when it is not so practicable, on account of the weather, for lumbering. The great deposits of iron ore would be easy of access, thereby making certain the construction of a blast furnace at your city, which has been so long anticipated and earnestly desired, as well as supylying present mills with said ore and giving an avenue for transportation under this point.

From the standpoint of the Harriman and Northeastern Railroad, such an improvement will be greatly appreciated. The immense coal field recently developed by the construction of the Harriman and Northeastern Railroad has possibilities of development second to none in the United States as to large tonnage of soft coal and its product, a superior class of coke. This road has not been open for business but little over a year and has already operating mines of capacity of 1,500 tons per day. They are pushing the construction toward completion of 200 coke ovens at the Brushy Mountain plant, and they contemplate building at least 500. At incidental times we constantly get wires to rush in coal at our switch for loading barges before the water recedes. The present mining interests, as well as two other parties contemplating developing of mines, are anxiously watching and hoping for said improvement. With the Emory River navigable to your town the year around, there would be thousands of tons of this product shipped by said means. Such tonnage always appreciates the cheaper means of transportation, and the towns of Knoxville and Chattanooga, intermediate towns, and beyond will gladly appreciate in any way at their command means to aid to the end you have in view, as they would be mutually benefited looking to the cheaper fuel, as well as the many other commodities of interchange. Show up the points of merit, and I do not deem it will need the political bolstering often effectively used in behalf of less meritorious improvements. This matter has been most earnestly urged upon myself by the executive committee of this company in New York, and I can say, so far as their influence may reach, you shall certainly have their support.

I can not question but if this matter is laid properly before Congress it will receive at once the proper aid to accomplish the end so earnestly desired.

Respectfully, yours,

G. W. CHANDLER, *General Manager.*

Messrs. WALTER C. HARRIMAN and G. B. DURELL,
Special Committee of the Business Men's League of the City of Harriman, Tenn.

LETTER OF MR. J. D. ROBERTS.

HARRIMAN, TENN., *March 1, 1897.*

GENTLEMEN: In response to your request for an opinion as to the benefits that would result to the iron interests of Harriman and vicinity by the improvement of the Emory River, making it navigable for light-draft boats the year around, I beg to say that the development of the Brushy Mountain coal fields, which, in my opinion, is the most valuable and cheaply mined body of coking coal in the South, has made this point one of the most desirable in the United States for the manufacture of pig iron and the opening of the Emory to year-round navigation would insure the erection of one or more blast furnaces here. Experience has shown that the ore taken from the large field on the Tennessee River near Kingston, where, according to expert calculations made by the State geologists of Tennessee and other competent geologists, there is something like 70,000,000 tons of ore in sight, is desirable and almost indispensable as a mixture with the ores taken from the foot of Walden Ridge, which are now extensively mined at Cardiff, 4 miles from here, as well as at this place, for consumption at Rockwood and Dayton, on the Cincinnati Southern Railway. This river ore is 24 miles from Harriman, by water, and, owing to its great thickness and cheapness of production, would be largely used here if cheap water transportation from the mines could be secured.

Assuming that one blast furnace of modern construction was built here, and that not more than one-half of the iron ore consumed should be taken from the river mines, there would be 60,000 to 70,000 tons a year to come up the river to Harriman.

Whether any considerable quantity of the product of the furnaces or rolling mill, the latter now here, would be shipped out by river I can not say, but the opening of the river would at least assure reasonable rates on this product by rail, enabling us to compete successfully with other points, and in addition would have the effect of incidentally increasing the river traffic, even if the direct shipment out should not be great. I know of no point where pig iron can be more cheaply produced than in Harriman, when the product of the extensive and valuable river ore beds can be shipped here the year around by water to meet the near-by Walden Ridge ores and the coke product of the Brushy Mountain mines. Should the Emory River be so improved as to allow shipments all the year, I would expect to see the tonnage by river demanded by the furnace interest alone reach from 60,000 to 125,000 tons per annum within the next few years.

Respectfully,

J. D. Roberts.

W. C. Harriman and George B. Durell, *City*.

LETTER OF MANAGER, BRUSHY MOUNTAIN COAL MINES.

Brushy Mountain Coal Mines,
Petros, Tenn., March 1, 1897.

Gentlemen: Referring to request of Mr. Chandler, that I address you a letter regarding the advantages that would inure to this section from the opening up of the Emory River to navigation, I beg leave to state that so far as our coal interests are concerned, I believe that it would ultimately lead to a very large business. Our facilities for mining large quantities of coal for shipment to the lower river points in competition with other mines are superior, in my judgment, to any mine located anywhere adjacent to the river in this State or Alabama. You, of course, understand that to go into such an enterprise would require large capital, but I believe with the assurance on our part that the coal can be furnished in proper quantities, others owning steamboats and barges would take up that branch of the business.

I regret that my limited time will not allow me to enter into full detail of my views on this subject, as it is a matter of considerable interest to us all.

Very respectfully,

J. T. Hill, *Manager*.

Geo. B. Durell, Esq., and W. C. Harriman, Esq.,
Harriman, Tenn.

LETTER OF PRESIDENT, HARRIMAN HOE AND TOOL COMPANY.

Harriman Hoe and Tool Company,
Harriman, Tenn., March 4, 1897.

Dear Sir: In reply to your inquiry of a few days ago, asking what benefit it would, in my opinion, be to the manufacturers of Harriman provided the Emory River was made navigable to Harriman all the year around, will say that such an improvement would benefit the manufacturers of Harriman in a great many other ways, but especially in two, which I will name. First, it would give us an outlet by river for our goods, and thus make us to a great extent independent of the railroad, a condition which is bound to insure us low freight rates. Second, it would enable us to draw our raw material from more distant points without increasing the cost of transportation therefor, and in some cases would open up to the factories a much more desirable source from which to draw their supplies of raw material.

The wood-working factories here, for instance, would then have all the advantages of Chattanooga in buying their lumber, as the logs could be stopped at Kingston and sawed there and shipped by boat here. Some of them are doing this now, but on account of the uncertainty of navigation in the Emory, they do not do near as much of this kind of business as they would like to do. We, ourselves, have a factory at Kingston for manufacturing our handles, but do not operate it more than four months in the year because at other seasons of the year we can not get the handles to Harriman, except by team, and this method of transportation costs more than we could afford to pay. I know that my neighbor, Mr. Rockwell, of the plow and handle company, has been buying as much of his oak from Kingston and neighboring towns on the river as he could get transported here. He says that this river oak is much better than the mountain oak and if the river were open the whole year around that he would get all his oak this way. Mr. Dame, of the furniture company, and Mr. Thorndike, of the measure factory, have made me the same statement. I have not seen anyone connected with the three other wood-working establishments in the city since the receipt of your request, but I have heard them all express themselves heretofore as anxious that the river should be improved so they could draw their lumber from the Clinch and Powells rivers.

The rolling mill, of course, is our largest industry here. It has a capacity of from 15,000 to 18,000 tons of iron a year, and has, heretofore, bought most of its pig iron from the Citico Furnace at Chattanooga, Tenn. If the river was improved I am told this pig iron could come by water to Harriman, and a very large part of the product of the mill, which goes to Knoxville and Chattanooga and intermediate towns, could be shipped by river also. In a word, I believe that the improvement of the river would be of very great benefit, indeed, to every factory that we have located here, and would certainly result in the early establishment of many more factories (especially a blast furnace), as then no better location than Harriman for manufacturing could be found in the entire country.

Yours, very truly,

GEO. B. DURELL, *President.*

MR. W. C. HARRIMAN, *City.*

LETTER OF MR. WALTER C. HARRIMAN.

FIRST NATIONAL BANK OF HARRIMAN,
Harriman, Tenn., March 5, 1897.

MY DEAR SIR: We were much pleased to receive your favor of the 3d, and I am very glad that I am able to furnish you with the following information, obtained from Mr. A. G. Watson, a large and prosperous farmer living on the Emory River below this city. I can assure you that this information is perfectly reliable and is fully confirmed by others.

Mr. Watson lives just below Webster, at a point on the river known as Coopers Landing; has lived there thirty years. From 1874 to 1877 six steamboats ran regularly on the Emory River between here (some coming only to Coopers Landing) and Knoxville, Chattanooga, Kingston, and up the Clinch River, bringing to Coopers Landing, Webster, and to this point agricultural products, etc., returning with coal and pig iron—the iron from the old Elverton Furnace, as I understand. The agricultural products so brought were for consumption along the Cincinnati Southern road, then building, making this place a distributing point. These six steamboats made about two trips per week each. They were compelled to take advantage of the high water, or "tides." There never has been a time since 1877 when more or less steamers have not come to this point loaded with corn, hay, and other agricultural products, averaging from one to three, whenever there was a tide, per week. Some years there are no more than three or four tides, while at others they are able to run two or three months during the year. These steamboats have a capacity from about 100 to 200 tons, and always come substantially loaded.

I may be able to reach some of the captains of these steamboats, although quite difficult to do so, and for purposes of confirmation hardly necessary. Other information will be forwarded as soon as possible.

Very respectfully, yours,

WALTER C. HARRIMAN.

DAN C. KINGMAN,
Captain, United States Engineers.

LETTER OF SECRETARY BUSINESS MEN'S LEAGUE OF HARRIMAN.

BUSINESS MEN'S LEAGUE OF HARRIMAN, TENN.,
Harriman, Tenn., March 6, 1897.

DEAR SIR: Replying to your request for some estimates relative to present and prospective commerce upon the Emory River, I would state, that, geographically, Harriman is the natural shipping center per railroad, and distributing point via boat for the entire territory drained by the upper Clinch and Powells rivers, embraced in the counties following, to wit: Roane, Knox, Anderson, Campbell, Union, Claiborne, and Grainger. According to the statistics of the Department of Agriculture for the State of Tennessee, these counties produced in the year 1889 on an aggregate of 176,783 acres nearly 3,000,000 bushels of corn, of which Roane County's share was about 500,000 bushels. In 1891 the average yield per acre throughout the State was larger, which resulted in an increase of about 30 per cent upon the same acreage, or about 4,000,000 bushels. In wheat the production in 1889 within the above-named counties amounted to 362,074 bushels upon 52,437 acres. In 1891 the average State yield per acre was a trifle over 11 bushels, which would show the production of wheat in said counties to have been fully 576,000 bushels. With the proper completion of the contemplated improvements upon the Emory River, the bulk of these products would find their way to this city, because—

First. Harriman is the only point within the reach of the producers where competitive freight rates are possible, all other points being dominated to a greater or less degree by a single railway line or system, whereas Harriman already possesses two—the Southern and the Cincinnati, New Orleans and Texas Pacific Railways—and the completion of the projected and partially-built Tennessee Central will add greatly to her advantage as a terminal and point of shipment.

Second. Farmers prefer sending their produce to a point well provided with banking facilities, all other things being equal. In this respect Harriman stands better prepared than almost any other city of its size in the South, possessing two excellent institutions, to wit, the First National and Manufacturers' National.

As an evidence of the truth of the above statement, at certain seasons of the year, even now, the storage capacity of the city is sorely taxed with produce that is sent here by the farmers when a favorable tide allows, with a view to future sale and shipment. The amount that is brought here, even under these unfavorable conditions, is increasing from year to year, as recognition of the above facts has forced itself upon the minds of the farmers, who are very quick to see the advantages as a market and point of shipment to the great trade centers that Harriman already possesses.

Recognizing these peculiar advantages, early in the history of Harriman some of Roane County's most energetic and substantial citizens organized the Emory River Transportation Company, with a view of successfully carrying on a business as indicated above. There has never been any lack of business for the company, it having been forced to discontinue any regular service upon the Emory on account of the uncertainty of the water. It is a fact, however, that our manufacturers and business men always arrange to take advantage of any satisfactory tide, at which times the trips are resumed.

Many other interests would be affected besides those stated above, such as lumber, manufacturing, mining, etc., as a point for the shipment of coal alone by barges via the Clinch, Tennessee, and Ohio rivers to points in the Ohio and Mississippi valleys, Harriman's position for business with an assured year-around waterway would be almost unequaled. These other subjects can be better handled by those who are better posted and consequently more competent.

Any service of mine that will further aid you in this direction will be most cheerfully rendered.

Very truly, yours,

S. W. WILLIAMS,
Secretary Business Men's League.

Hon. W. C. HARRIMAN,
Chairman of the Committee on Emory River Improvement.

LETTER OF MR. J. W. SCOTT.

EAST TENNESSEE LAND COMPANY,
Harriman, Tenn., March 8, 1897.

MY DEAR SIR: In reply to your favor of recent date, will say that if we can succeed in getting our rivers improved, one of the principal exports of Harriman and vicinity will be coal.

The great coal fields of the Cumberland Plateau lies in Morgan, Scott, Campbell, and Anderson counties, Tenn. The natural outlet for a great portion of this coal field is Harriman. The Cincinnati Southern Railroad runs along the west side, the Knoxville and Ohio Railroad skirts its eastern border, and the Waldens Ridge Division of the Southern Railway follows the foot of Waldens Ridge just outside of its southern boundary. The area of this coal field contiguous to Harriman embraces some 30,000 to 50,000 acres, on which there are found from 3 to 6 good workable seams of coal from above 2 feet to 6 feet in thickness. According to analysis these upper coal measures contain but little sulphur and are generally low in ash, and there is no doubt that several of the beds will give large yields of excellent coke. The general formation is regular.

The Harriman and Northeastern Railway runs from Harriman along the bank of the Emory River and enters into the heart of this coal field. By extensions and short branches it can be made to reach every part of it. The geographical position of Harriman at the south end and at the gateway to this coal field, with the proposed river improvements, will give it a great advantage in competing for the trade of the South and Southwest; in fact, we will have a monopoly of this trade so far as coal of superior quality is concerned.

Coal can be taken to Rockwood, Dayton, Chattanooga, and South Pittsburg to supply the blast furnaces at these points and to towns on the Tennessee, Ohio, and Mississippi rivers, etc., via Emory River when so improved. I intended to give you an approximate estimate of the amount of coal in this coal field, but suffice to say that the supply is inexhaustible, and when figured at a royalty of 8 cents per ton, its value is over $100,000,000. The proposed river improvements will be far-reaching in their benefits, and I trust that we may get the necessary appropriation.

Yours, truly,

J. W. Scott.

Hon. W. C. Harriman, *Chairman, etc.*

APPENDIX C C.

IMPROVEMENT OF OHIO RIVER AND OF MUSKINGUM RIVER, OHIO.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ohio River.
2. Operating snag boat on Ohio River.
3. Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pennsylvania.
4. Movable Dams Nos. 2, 3, 4, 5, and 6, Ohio River.
5. Muskingum River, Ohio.
6. Operating and care of locks and dams on Muskingum River, Ohio.
7. Examinations, surveys, and contingencies of rivers and harbors. Observations on Muskingum River.

EXAMINATION.

8. Ohio River, from Marietta to its mouth.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 16, 1897.

GENERAL: I have the honor to transmit herewith the annual reports on the works under my charge June 30, 1897.

First Lieut. Mason M. Patrick, Corps of Engineers, was under my immediate orders until May 15, 1897. An acknowledgment is due him for splendid service rendered.

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

C C 1.

IMPROVEMENT OF OHIO RIVER.

In the Annual Report of the Chief of Engineers for 1896, Part IV, pp. 2062–2063, is a general statement of the condition of the river, drainage area, population, commerce, etc., and the methods applied to the improvement.

During the seasons of both 1896 and 1897, operations were much interrupted by high water, but it is believed that in general all the work carried on has accomplished the results intended, and some of the best-informed river men state that the channel in the lower river has been much improved by the work done last year.

Much of the information contained in the tables below relating to the commerce of the Ohio River has been furnished by Mr. C. B. Murray, superintendent of the Cincinnati Chamber of Commerce. Some data was also supplied by Mr. J. Frank Tilley, assistant secretary of the Pittsburg Coal Exchange.

WORK DONE DURING THE YEAR IN DETAIL.

Dam between Davis and Neville Islands, 4.75 miles below Pittsburg.—Undermining for a length of 50 feet was repaired by a row of sheet piling, spiked to the lower side of the dam, and the river bed below restored with a filling of riprap. The labor was mainly performed by the regular force at Davis Island Dam.

Duff's bar, 7½ miles below Pittsburg.—The channel here is very short and crooked, and in low water boats frequently stick; in getting off they scrape up piles of gravel, increasing the difficulty of navigation. As dredging would be injurious by draining the pool and transferring the trouble to the bar above, a boat with iron scraper, 15 feet wide at the bow, was employed to level the lumps of gravel. Three days' work, at $40 per day, put the channel in good shape.

Phillis Island, 35 miles below Pittsburg.—The dredging here was done at the urgent request of the Pittsburg Coal Exchange and other interested parties, the narrow channel being obstructed by two bars on opposite sides, so that towboats ascending with empties on a low stage in endeavoring to avoid one could hardly escape grounding on the other. Between October 1 and December 8 both bars were removed to the channel depth by a hired dredge, making a comparatively straight course 200 feet wide. Total material dredged, 16,024 cubic yards, at 30 cents per cubic yard.

Dams and shore protection at Marietta Island, 168 miles below Pittsburg.—The repair of two dams and construction of loose-stone dikes for shore protection is stated in detail in the report of Mr. Edmund Moeser, appended.

Survey of Ohio River from Marietta to Pittsburg.—The river and harbor act of June 3, 1896, authorized the expenditure of $25,000, or so much thereof as might be necessary, on this survey, and required a report on the number of movable dams necessary to improve the river between said points to provide 6 feet of water therein at low water, and the proper location and probable cost of said dams.

Pursuant to the above, the survey was begun September 17, 1896, and continued until November 30. All branches of the work were resumed June 22, 1897, and at the end of the year the main transit line had reached a point 53 miles below Pittsburg. Work during 1896 was greatly retarded by high water. With favorable conditions, it is expected that the field work will be completed by the end of the summer.

The survey is under the efficient supervision of Mr. R. R. Jones, assistant engineer, an extract from whose report is appended.

Blennerhassett Island, 184 miles below Pittsburg.—The dam built some years ago between this island and the West Virginia shore, with a view to concentrating the water in the channel on the Ohio side, was reported to have produced a scour and caving of the bank just below the head of the island, of which owners complained, as no erosion took place prior to the building of the dam. To check further caving a project was approved June 16, 1897, for two short spur dikes and rock revetment of the bank, at an estimated cost of $2,400. Bids for the work have been invited, by circular letter and posters, to be opened July 6, 1897.

Guyandotte Bar, 303 miles below Pittsburg.—Additional work for improving the new channel projected in 1895 (Annual Report, 1896, part 4, pp. 2064, 2084) was begun by the United States dredges on June 1, a deeper and wider channel being necessary for safe navigation at low stages.

By June 29 the width of channel had been increased from 125 to 250 feet for a distance of 1,500 feet, giving safe passage for packets and tows at all stages.

Craigs Bar, 537.5 miles below Pittsburg.—The improvement in view was the closing of the crooked channel along the Indiana shore by two loose-stone dikes, and to aid the formation of a straight channel on the Kentucky side by dredging. The dikes proposed were respectively 830 and 850 feet long, elevation 3 or 4 feet above low water, 12 feet wide at base, 5 feet at crown, upstream slope 1 on 1, downstream slope 1 on 2, with shore protection at the root and a dike head extending upstream 50 feet; 1 row of piles or guiding timbers 50 feet apart, to be driven on line of dike, and 1 pile at upper end of head.

Under ten-day circulars bids for these dikes were opened July 6, 1896, and award made to the lowest bidders, Willard & Cornwell, of Louisville, Ky., but these parties when notified declined to carry out their proposal, and the work was awarded to the next lowest bidders, Richardson & Hall, of Newport, Ky. Work was begun September 6, and was practically completed on November 28, when high water suspended operations; there only remained the building up of dike heads and some leveling of stone in one dike to complete the work. Total stone placed in both dikes, 7,227.8 cubic yards, at $1.19 per cubic yard, which includes the piling.

The dredging was done between August 24 and November 27 by the United States dredges and a hired plant, giving a channel through the bar 3,800 feet long, 6 feet below low water, and of a minimum width of 90 feet on the highest part of the bar, which is about one-half the space required for the safe passage of boats. The additional dredging required will be begun at once.

Total excavation made:	Cubic yards.
By United States dredges, August 31 to November 27	36,006
By plant hired from Wm. A. Kirk, August 24 to November 27	18,313

Flint Island, 683 miles below Pittsburg.—On completing work at French Island the Brown dredging plant was transferred to this place to finish the dredging done in 1895. Work was carried on from October 15 until stopped by high water on November 30, the area dredged consisting of two parallel cuts through the gravel bar of 5 feet depth at low water, 50 feet wide for a distance of 1,425 feet, and 27 feet wide for a further distance of 2,375 feet. When the work closed there was a strong current through the line of the completed cut, but apparently no tendency to wash out material, and further dredging will probably be necessary. Total excavation during season, 17,115 cubic yards.

A number of embedded logs encountered in dredging were also removed.

French Island, 761 miles below Pittsburg.—This place is one of the first to give trouble in the lower river, and although much benefited by the dike work and dredging done in 1893, 1894, and 1895, further effort was necessary to give the channel the desired course, and an amended plan was approved for two loose-stone dikes, 650 and 870 feet long, respectively, 12 feet wide at crown, with the tops about 2 feet above low water. Under ten-day circulars, agreement was made with Bedford, Weikel & Nugent, of Evansville, Ind., at $1.14 per cubic yard for stone in place. In June, 1896, 23 piles 80 feet apart were driven on line of dikes, though not called for in the agreement. Delivery of stone began July 14, and by August 29 all required was deposited on the lines of the dikes, but high water prevented about four days' work of shaping up to complete. Total stone expended, 2,127 cubic yards.

The dredging plant of H. S. Brown was engaged from September 22 to October 7 in leveling off shoals in the channel to required depth, also removing a small quantity of stone found on line of old dike. Total excavation, 4,459 cubic yards.

Evansville, Ind., 783 miles below Pittsburg.—Improvement of harbor and prevention of cut-off. The conditions prevailing and necessity for improvement were stated in full in the reports of Lieutenant-Colonel Stickney (Annual Reports of the Chief of Engineers for 1895, part 3, p. 2388, and 1893, part 3, p. 2520) on the respective subjects. A project for the harbor, slightly modified from the plan proposed in the report of 1895, was approved in August, 1896, the work authorized being the construction of about six dikes of lengths varying from 180 to 1,500 feet, on an artificial (rock) foundation 30 feet wide and 1 foot thick, with two rows of piles 10 feet apart and 10 feet between rows, the space between to be filled with fascines of brush to a level of 2 feet above low water, all piling then connected by plank, the brush weighted with stone to 4 feet above low water, and tops of piles sawed off to required height.

Bank protection.—The plan adopted is to revet portions of the bank and bed of the river on the Kentucky side, at some ten or eleven places, from 1 to 6 miles above Evansville, grading the bank where necessary; rock to be laid to a depth of 1 foot for 10 feet above low-water surface, and for a length of about 200 feet at each place. Below low-water surface brush mattresses ballasted with stone will extend 25 feet into the river. Bundled brush weighted with stone will be used as required in low places, which will prevent water from flowing through in earlier flood stages.

Both contracts for the above works were awarded to Eichel & Arnold and Eigenmann & Hollerbach, of Evansville, Ind.; contracts approved January 9, 1897.

Work was begun June 8 and continued on three of the dikes until the 25th, when suspended by high water.

Material expended:

Piles	number..	228
Brush	cords..	15
Stone	cubic yards..	1,154

Embankment at Shawneetown, Ill., 848 miles below Pittsburg.—High water in the spring of 1896 having washed away some earth from this work and otherwise endangered its stability, the residents requested that the funds available (about $1,370) might be used in the necessary repairs. An examination was made by Mr. J. N. Caldwell, assistant engineer, and a project submitted on July 1, 1897, for about 5,000 cubic yards of earthwork, at an estimated cost of $1,250.

Golconda, Ill., 890 miles below Pittsburg.—According to an examination recently made by Mr. J. N. Caldwell, assistant engineer, it is thought that the dredging of the neck which connects the large gravel bar with the shore will improve the landing, and have some effect on the large bar. The project approved June 30, 1897, provides for dredging by one of the hired plants to a depth of not more than 6 feet below low water and as wide as practicable with the amount available, $3,000. The work is not yet begun.

New Liberty, Ill., 909½ miles below Pittsburg.—A petition was recently filed by citizens of this place for some action regarding the caving of the river bank, caused by high water and a slough back of the town. An examination has been made, and the conclusion reached was that no danger need be apprehended by the citizens of that locality.

Brooklyn, Ill., 923 miles below Pittsburg.—About $21,500 was expended in 1884, 1889, and 1892 in the removal of rocks and the cemented gravel reef in front of the village. Since the act of June 3, 1896, appropriating $10,000 for continuing the work, there has been no low stage of the river when it was practicable to ascertain where further work should be done, until June, 1897, when Mr. J. N. Caldwell, assistant engineer, made the examination. A project for the work is being prepared.

Mound City, Ill., 959 miles below Pittsburg.—In 1892 Congress appropriated $30,000 for improving navigation at this place, and most of the work projected was accomplished in 1893–94. (See Annual Report, 1895, part 3, p. 2330.) The act of June 3, 1896, added $5,000 to the unexpended balance of like amount, making $10,000 available for continuing the work. A project approved May 21, 1897, provides for continuing the removal of the cemented gravel bar by dredging to a least depth of 6 feet below low water, with one of the plants hired under contract, and by drilling and blasting, if found necessary. The work is not yet begun, as the river has been too high toenable dredges to work.

Operating United States dredges.—The plant consists of 2 dredges, 4 dump scows, and 1 flatboat, with a towboat as tender hired for each working season, fuel for operating the dredges being included in the contract price. As the dredging season usually begins before the close of the fiscal year, the report necessarily comprises operations during parts of two distinct seasons.

For the season of 1896 the tender was furnished by F. P. Lynch, under contract approved July 1, 1896, at $30.75 per day and $3 per day additional when at work below Louisville, Ky. The tender for 1897 is furnished by Richardson & Kraft; contract approved April 10, 1897, at $30 per day and $2 per day additional for work below Louisville.

During 1896 dredging was much interrupted by high water and was also hampered by delay in repairs to the *Ohio*, which were not completed until the latter part of October. Most of the season's work was therefore done by the *Oswego*, which was sent early in July to Wheeling Creek Bar, where a sudden freshet had deposited a mass of débris and made the channel almost impassable for towboats. The *Oswego* remained there until the latter part of August and then went to Craigs Bar. Her work there was suspended by high water from October 3 until November 6, when it was resumed by both boats. (See Craigs Bar, above.)

November 27 another rise occurred; and there being no prospect of further dredging, the fleet went to the usual winter quarters in the mouth of the Kentucky River.

On March 7, 1897, the boats were brought to Cincinnati for the repairs necessary each season before beginning work, a large part of the material dredged being very destructive to the machinery. The repairs were finished in May, and on June 1 work was begun at Guyandotte Bar in deepening and widening the channel dredged in 1895. (See Guyandotte Bar, above.) This was completed on June 29, and on June 30 the dredging fleet left Guyandotte for work at Craigs Bar.

The dredging operations have been under the efficient supervision of Mr. E. J. Carpenter, assistant engineer, extracts from whose reports are appended.

During the fiscal year the dredges worked as follows:

Name of locality.	Material dredged.	Obstructions removed.	
		Rocks.	Weight.
	Cub. yds.	*No.*	*Tons.*
Wheeling Creek Bar, 1896	14,179	2	5
Craigs Bar, 1896	36,066	....	....
Guyandotte Bar, 1897	23,491	....	....
Total	73,736	2	5

Hired dredging plants.—In addition to the work done by the Government dredges, which are kept fully employed during the season, a large amount of excavation has been necessary on the lower river to carry out the improvements designed for maintaining navigation at low stages. For this purpose two plants, each consisting of 1 dredge, 1 towboat, and 3 dump scows, were hired under contract in 1896 and 1897. The plants hired in 1896 were furnished by William A. Kirk, of Madison, Ind., and H. S. Brown, of Quincy, Ill., under contracts approved August 6 and 15, 1896, respectively. The same parties were the lowest bidders in 1897; contracts approved April 14 and 16, respectively. The work done is stated in the reports on Craigs Bar, Flint Island, and French Island. The cost of dredging by this method during 1896 was about 23½ cents per cubic yard, which is somewhat higher than the rate in ordinary seasons under favorable conditions. Owing to frequent stages of high water in 1896 considerable time was lost by inactivity, and in one instance the plants were discharged and reemployed when the river had fallen, but this course is open to the objection that the plant when wanted may not be available.

Up to June 30, 1897, continued high water in the lower river has prevented work by either of the plants under contract for this season.

Ice piers.—Under the river and harbor act of August 17, 1894, providing for an ice pier at or near Syracuse, Ohio, or at or near Hartford, W. Va., "upon the plans heretofore adopted for such piers in the Ohio River," the latter site had been selected as more suitable for the needed protection, and at the beginning of the year a contract was in force with Walter S. Ware for a pier consisting of two timber cribs filled with stone and for the additional pier (one crib) required by the same act in the harbor previously built at Middleport, Ohio.

Work on the Hartford pier was begun in the latter part of July and completed October 6, 1896.

Material expended:

Stone	cubic yards..	3,069
Timber	feet B. M..	96,241
Driftbolts	pounds..	7,569
Mooring rings	do....	2,492

Total cost of material, $4,659.55.

The Middleport pier was begun October 7 and finished November 11, 1896.

Material expended:

Stone	cubic yards..	1,062
Timber	feet B. M..	45,263
Driftbolts	pounds..	3,381
Mooring rings	do....	1,246

Total cost of material, $1,901.87.

The ice harbor at Syracuse, Ohio, named as alternative in the act of 1894, was afterwards included in the act of 1896, which also required a harbor at or near the mouth of the Big Hocking River. At the latter place the best site was found to be on the West Virginia side, opposite Hockingport, where there is a rock bar or ledge favorably situated on a convex shore with deep water below and where coal fleets occasionally make a harbor.

Projects have been submitted for building ice piers by contract at both of these localities, each to consist of two cribs, at an estimated cost of $7,000 for each harbor. Bids for this work have not yet been advertised. The Secretary of War has authorized that the work for the present be deferred.

A general description of the construction of ice piers on the Ohio, with other information on this subject, is given in the Annual Reports of the Chief of Engineers for 1893, part 3, page 2446, and for 1896, part 4, page 2068.

Encroachments.—Violations of the law prohibiting the building of structures or dumping of material that may become obstructions to the waterway are much less frequent than formerly, owing, no doubt, to the fact that the enactments on this subject have become more generally known. Where encroachments have been commenced the parties have ceased as soon as notified, and during the year it has not been necessary to report any case to the legal authorities.

Harbor lines.—Office work on the location of harbor lines at Pittsburg was continued until January, 1897. At Wheeling work was begun in February and continued until April in making observations and obtaining data of high-water stages and also in establishing permanent bench marks when practicable. Similar work was then taken up at Cincinnati and continued until June.

In July, 1896, the Wheeling Bridge and Terminal Railway Company made application to the Secretary of War for permission to lay a small portion of its track and make the necessary fill for the support of the same outside the established harbor line on the east side of the Ohio River at Benwood, W. Va. Permission was granted, and the work was completed under the supervision and approval of this office in January, 1897.

Application was also made by the Pennsylvania Sand Company to maintain a platform, previously constructed, on the east bank of the Ohio River at Wheeling. Although outside the established lines, the application was favored by a number of pilots and others, and the Secretary of War permitted the platform to remain unless it should prove an obstruction.

Bridges.—Under date of December 28, 1896, a Board of Engineer Officers was constituted to consider and report upon the subject of alterations to certain bridges, including that of the Pittsburg, Cincinnati and St. Louis Railroad Company at Steubenville and that of the Baltimore and Ohio Railroad Company at Bellaire. The report of the Board was submitted May 3, 1897.

Reports of Boards were also made on plans of bridges proposed between Ashland, Ky., and Ironton, Ohio, and between Benwood, W. Va., and Bellaire, Ohio, submitted, respectively, October 8, 1896, and April 23, 1897.

Work on the reconstruction of the bridge operated by the Pennsylvania Railroad Company between Newport, Ky., and Cincinnati, Ohio, was carried on throughout the year and is nearly finished. The removal of the piers and obstructions of piling and stone around them is now going on.

STAGES OF THE OHIO RIVER DURING 1896.

The following are the records of the gauges at Pittsburg, Cincinnati, and Evansville, which may be taken to represent the navigable condition of the Upper, Middle, and Lower Ohio:

Gauge of Davis Island Dam, near Pittsburg, Pa.

[When the dam is up, low-water readings must be obtained from the gauge at the lower end of the lock. On this gauge 3 feet 2 inches corresponds to a navigable depth of 3 feet, and 6 feet corresponds to the same depth in the river.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	12	10.7	3.8
February	0	29	26	13.1	4.9
March	0	31	30	19.9	5.9
April	0	30	30	19.1	6.7
May	0	31	8	7.9	3.4
June	0	30	6	11.1	3.5
July	0	31	17	21	3.9
August	4	27	11	16.2	2.8
September	21	9	0	4.6	2.2
October	0	31	22	12.4	4.4
November	0	30	22	11.5	4
December	0	31	19	12.3	3.8
Total	25	341	203	....	....

Cincinnati gauge.

[The zero of this gauge is about 2 feet below low water; readings of about 4 feet correspond to about 3 feet in the channel, and those of 7 feet to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	31	24.2	7.5
February	0	29	29	33.8	12.3
March	0	31	31	35.8	12.4
April	0	30	30	47.7	15.5
May	0	31	31	17.8	7.8
June	0	30	30	22.8	8.9
July	0	31	31	40.5	9.8
August	0	31	31	41.8	10
September	0	30	24	9.3	5.5
October	0	31	31	25.4	9.8
November	0	30	30	21.4	9.7
December	0	31	31	29.2	10.1
Total	0	366	360	....	....

Evansville gauge.

[The zero of this gauge is about at low-water line; readings of 2 feet correspond to about 3 feet in the channel, and readings of 6 feet correspond to about 6 feet in the channel.]

Month.	Depth in channel.			Gauge readings.	
	Under 3 feet.	3 feet and over.	6 feet and over.	Highest.	Lowest.
	Days.	*Days.*	*Days.*	*Feet.*	*Feet.*
January	0	31	26	19.3	5.6
February	0	29	29	28	11.3
March	0	31	31	32	9
April	0	30	30	33	11.7
May	0	31	31	12.2	6.2
June	0	30	30	10.8	7
July	0	31	31	28.5	9.4
August	0	31	31	30.5	7.4
September	1	29	5	8.5	2.9
October	0	31	28	16.4	3.3
November	0	30	30	15.9	6.8
December	0	31	31	23.6	9.2
Total	1	365	333	....	....

OPERATION OF DRAWS IN HIGH BRIDGES.

There are no low drawbridges on the Ohio River. The general Ohio River bridge law requires that all bridges shall have a height of at least 40 feet above high water, and, since large steamboats require more than 40 feet, it is also provided that all bridges below the Cincinnati Suspension Bridge shall have a draw for use in high water, unless they give a clearance of at least 53 feet above high water. There are three high-water draws on the Ohio River, but the draw in the Ohio Falls Bridge at Louisville is exceptionally located, and no record of its operation is kept. Reports received from the Cincinnati Southern Railroad Bridge at Cincinnati and the Kentucky and Indiana Bridge at Louisville state that the draws were not opened for the passage of boats during the calendar year ending December 31, 1896.

STOPPAGE OF NAVIGATION BY ICE.

Very little interruption from ice occurred during the winter of 1896–97, the only suspension on this account being about ten days between January 25 and February 6.

LOSSES BY COLLISION WITH BRIDGES.

The following table shows the reported losses sustained by the commerce of the Ohio River by collision with the piers of bridges crossing the Ohio River to the end of the calendar year 1896:

Date, etc.	Owner.	Steamboat.	Loss.	Amount.
Stubenville Bridge:				
Previously reported				$93,108.00
February, 1896	C. Jutte & Co	George Shiras	3 coal boats	4,500.00
Total				97,608.00
Kenova Bridge:				
Previously reported				20,900.00
February 19, 1896	W. H. Brown Sons	Volunteer	2 coal boats	3,500.00
Total				24,400.00
Cairo Bridge:				
Previously reported				23,496.65
April 28, 1896	John A. Wood & Son	Jno. A. Wood	Coal boat	1,623.30
Total				25,119.95

Losses by collisions with Ohio River bridges to December 31, 1896.

Beaver Bridge	$56,340.00
Steubenville Bridge	97,608.00
Wheeling and Martins Ferry Bridge	9,800.00
Bellaire Bridge	137,656.00
Parkersburg Bridge	77,777.00
Point Pleasant Bridge	9,600.00
Kenova Bridge	24,400.00
Newport and Cincinnati Railroad Bridge	44,107.00
Covington and Cincinnati Railroad Bridge	93,300.00
Cincinnati Southern Railroad Bridge	9,812.00
Louisville and Jeffersonville Bridge	7,800.00
Ohio Falls Bridge	80,350.00
Kentucky and Indiana Bridge	27,767.00
Henderson Bridge	20,520.00
Cairo Bridge	25,119.95
Total	721,956.95

ESTIMATES.

In work of the character of that for the improvement of the Ohio River it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and therefore it is impossible to submit estimates for complete improvement. The work must be progressive and tentative, and, owing to the varied interests and communities along nearly 1,000 miles of river, the locations of works must be at considerable distances apart, so that no one reach of river can be taken in hand and improvement completed in advance of other parts of the river unless large amounts of money are provided. The great and growing commerce of this river, its numerous cities, and the rapid increase of the already large population of the valley should appeal in strong terms for adequate appropriations for such betterment of the navigation as it is certain can be obtained by well-known methods. The sum of $1,000,000 can be profitably used and produce immediate results in great improvement for the movement of the vast commerce of the river. Attention is particularly invited to the commercial statistics appended.

Money statement.

July 1, 1896, balance unexpended		$406,219.08
June 30, 1897, amount expended during fiscal year		109,809.36
July 1, 1897, balance unexpended		296,409.72
July 1, 1897, outstanding liabilities	$12,651.40	
July 1, 1897, amount covered by uncompleted contracts	52,734.25	
		65,385.65
July 1, 1897, balance available		231,024.07
Amount that can be profitably expended in fiscal year ending June 30, 1899		1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Statement of amounts and dates of all appropriations for this work.

Act of Congress.	Appropriation.	Allotment.	Remarks.
March 3, 1827	$30,000.00		
March 3, 1835	50,000.00		
July 2, 1836	20,000.00		
March 3, 1837	60,000.00		
July 7, 1838	50,000.00		
June 11, 1844	100,000.00		
March 3, 1847	6,479.25		
August 30, 1852	90,000.00		
June 23, 1866		$172,000.00	Improving Mississippi, Missouri, Arkansas, and Ohio rivers.
Do		80,000.00	Snag boats and apparatus for improving Western rivers.
March 2, 1867	100,000.00		
July 25, 1868		85,000.00	Repair, preservation, extension, and completion of river and harbor works.
July 11, 1870	50,000.00		
March 3, 1871	50,000.00		
June 10, 1872	200,000.00		
March 3, 1873	200,000.00		
June 23, 1874	150,000.00		
March 3, 1875	300,000.00		
August 14, 1876	175,000.00		
June 18, 1878	300,000.00		
Do	50,000.00		Harbor of refuge at or near Cincinnati.
March 3, 1879	250,000.00		
June 14, 1880	250,000.00		
March 3, 1881	350,000.00		

Statement of amounts and dates of all appropriations for this work—Continued.

Act of Congress.	Appropriation.	Allotment.	Remarks.
March 21, 1882	$100,000.00	....	Continuing work on Davis Island Dam.
August 2, 1882	350,000.00	....	
Do	16,000.00	....	Harbor of refuge near Cincinnati, Ohio.
July 5, 1884	600,000.00	....	
Do	17,000.00	....	Do.
August 5, 1886	375,000.00	....	
August 11, 1888	330,000.00	....	
September 19, 1890	300,000.00	....	
January 19, 1891	2,128.87	....	Relief of Stubbs & Lackey. Treasury settlement No. 2598.
July 13, 1892	360,000.00	....	
August 17, 1894	250,000.00	....	
June 3, 1896	250,000.00	....	
Total	5,831,608.12	$337,000.00	

Total of appropriations, 1827–1896	$5,831,608.12	
Total of allotments, 1827–1896	337,000.00	
Received from sales, 1866–1893	7,790.50	
		$6,176,398.62
Appropriations not drawn, 1827, 1852	5,023.47	
Allotments not drawn, 1866, 1868	43,134.60	
Returned by Treasury settlements	30.07	
Amounts transferred to other works	125,168.44	
		173,356.58
Total		6,003,042.04

Abstract of proposals for furnishing one or more dredging plants, each consisting of 1 dredge, 1 towboat, and 3 dump scows, for use on the Ohio River, received in response to advertisement dated July 13, 1896, and opened at Cincinnati, Ohio, July 24, 1896, by Maj. W. H. Heuer, Corps of Engineers.

No.	Name of bidder.	Dredge boat and 3 dump scows.		Towboat.		Remarks.
		Price per day when at work.	Price per day when inactive.	Price per day when at work.	Price per day when inactive.	
1	S. F. Dana	$40.00	$40.00	$35.00	$35.00	No dump scows.
2	The Licking Valley Coal Digger Co.	55.00	40.00	40.00	35.00	Do.
3	Wm. A. Kirk	35.00	20.00	30.00	22.50	Recommended for acceptance.
4	Monongahela and Western Co.	65.00	50.00	50.00	45 00	2 dump scows; dredge Western.
5	.....do	39.75	35.00	45.00	40.00	2 dump scows; dredge No. 3.
6	H. S. Brown	45.00	15.00	30.00	15.00	Recommended for acceptance.

Abstract of proposals for constructing dikes and bank protection in the Ohio River at and near Evansville, Ind., received in response to advertisement dated November 11, 1896, and opened at Cincinnati, Ohio, December 11, 1896, by Maj. W. H. Heuer, Corps of Engineers.

No.	Name of bidder.	Dike work.						Total bid.
		Piles (740).		Rock (7,000 cubic yards).		Brush fascines (1,700 cords).		
		Price each.	Amount.	Price per cubic yard.	Amount.	Price per cord.	Amount.	
1	Wm. A. Kirk	$4.00	$2,960.00	$1.65	$11,550.00	$2.25	$3,825.00	$18,335.00
2	James Short	3.40	2,516.00	1.14	7,980.00	1.50	2,550.00	13,046.00
3	I. V. Hoag	5.00	3,700.00	1.50	10,500.00	4.00	6,800.00	21,000.00
4	Jacob Richtman & Sons	5.50	4,070.00	1.62	11,340.00	2.82	4,794.00	20,204.00
5	Eichel & Arnold and Eigenmann & Hollerbach*	3.35	2,479.00	.80	5,600.00	1.15	1,955.00	10,034.00
6	Bedford, Weikel & Nugent	8.53	6,312.20	1.30	9,100.00	1.87	3,179.00	18,591.20

Abstract of proposals for constructing dikes and bank protection in the Ohio River at and near Evansville, Ind., etc.—Continued.

No.	Name of bidder.	Bank protection.							Aggregate bid.
		Rock (7,000 cubic yards).		Brush fascines (3,000 cords).		Brush mats (90).		Total bid.	
		Price per cubic yard.	Amount.	Price per cord.	Amount.	Price each.	Amount.		
1	Wm. A. Kirk	$1.65	$11,550.00	$2.25	$6,750.00	$25.00	$2,250.00	$20,550.00	$38,885.00
2	James Short	1.18	8,260.00	1.65	4,950.00	8.00	720.00	13,930.00	26,976.00
3	I. V. Hoag	1.50	10,500.00	4.00	12,000.00	20.90	1,881.00	24,381.00	45,381.00
4	Jacob Richtman & Sons	1.65	11,550.00	2.50	7,500.00	3.10	279.00	19,329.00	39,533.00
5	Eichel & Arnold and Eigenmann & Hollerbach *a*	.90	6,300.00	1.15	3,450.00	12.50	1,125.00	10,875.00	20,909.00
6	Bedford, Weikel & Nugent	1.51	10,570.00	2.10	6,300.00	32.50	2,925.00	19,795.00	38,386.20

a Recommended for acceptance.

Abstract of proposals for furnishing towboat as tender to United States dredges Ohio and Oswego, received in response to advertisement dated February 5, 1897, and opened at Cincinnati, Ohio, March 8, 1897, by Maj. W. H. Heuer, Corps of Engineers.

No.	Name of bidder.	Price per day.
1	S. D. Davis, mother, sister, and brothers	$39.00
2	Charles Hook, managing owner	37.00
3	B. F. Young	32.50
4	Hulings Bros	35.00
5	Fredrick Penny Lynch	33.33⅓
6	Richardson & Kraft *a*	30.00

a Recommended for acceptance.

Abstract of proposals for furnishing one or more dredging plants, each consisting of 1 dredge, 1 towboat, and 3 dump scows, for use on Ohio River, received in response to advertisement dated February 23, 1897, and opened at Cincinnati, Ohio, March 25, 1897, by Maj. W. H. Heuer, Corps of Engineers.

No.	Name of bidder.	Dredge-boat and 3 dump scows.		Towboat.	
		Price per day when at work.	Price per day when inactive.	Price per day when at work.	Price per day when inactive.
1	Chas. H. Appleton	$75.00	$45.00	$50.00	$30.00
2	Monongahela & Western Co	65.00	25.00	30.00	20.00
3	Wm. A. Kirk *a*	40.00	28.00	30.00	20.00
4	H. S. Brown *a*	40.00	28.00	30.00	20.00

a Recommended for acceptance.

List of contracts in force during the fiscal year ending June 30, 1897.

Hire of towboat for United States dredges: F. P. Lynch; June 8, 1896; approved July 1, 1896; commence when directed; terminate about December 1, 1896.

Ice breakers at Middleport, Ohio, and Hartford, W. Va.: Walter S. Ware; June 26, 1896; approved July 3, 1896; commence August 1, 1896; terminate December 31, 1896.

Hire of dredging plant: Wm. A. Kirk; August 1, 1896; approved August 6, 1896; commence when directed; terminate when discharged.

Hire of dredging plant: H. S. Brown; August 8, 1896; approved August 15, 1896; commence when directed; terminate when discharged.

Constructing dikes in Ohio River at and near Evansville, Ind.: Eichel & Arnold and Eigenmann & Hollerbach; January 2, 1897; approved January 9, 1897; be prepared to commence April 1, 1897; terminate December 1, 1897.

Constructing protection work on Ohio River near Evansville, Ind.: Eichel & Arnold and Eigenmann & Hollerbach; January 2, 1897; approved January 9, 1897; be prepared to commence April 1, 1897; terminate December 1, 1897.

Hire of towboat for United States dredges: Richardson & Kraft; March 30, 1897; approved April 10, 1897; commence when directed; terminate about December 1, 1897.

Hire of dredging plant: Wm. A. Kirk; April 7, 1897; approved April 14, 1897; commence when directed; terminate when discharged.

Hire of dredging plant: H. S. Brown; April 10, 1897; approved April 16, 1897; commence when directed; terminate when discharged.

STAGES OF THE OHIO RIVER.

Highest, lowest, and average stages of the Ohio River at Cincinnati each calendar year from 1860 to 1896, inclusive, with the highest stage during the floods of 1832 and 1847.

Calendar year.	Highest stage.			Lowest stage.			Average for the year.	
	Date.	Stage.		Date.	Stage.			
		Ft.	*In.*		*Ft.*	*In.*	*Ft.*	*In.*
1832	Feb. 18	64	3	....	....		....	
1847	Dec. 17	63	7	....	....		....	
1860	Apr. 16	49	2	Oct. 3	5	4	16	0
1861	Apr. 19	49	5	July 13	5	1	19	1
1862	Jan. 24	57	4	Oct. 31	2	4	17	5
1863	Mar. 12	42	9	Oct. 6	2	6	15	0
1864	Dec. 23	45	1	Aug. 6	3	1	16	8
1865	Mar. 7	56	8	Oct. 19	5	8	21	10
1866	Sept. 26	42	6	Aug. 17	4	9	19	2
1867	Mar. 14	55	8	Oct. 19	3	0	17	0
1868	Mar. 30	48	3	July 21	5	1	18	8
1869	Apr. 2	48	9	Aug. 21	5	4	19	8
1870	Jan. 19	55	3	Oct. 4	3	10	17	10
1871	May 13	40	6	Oct. 12	2	8	11	10
1872	Apr. 13	41	9	Oct. 14	3	0	11	8
1873	Dec. 18	44	5	Oct. 12	3	8	18	5
1874	Jan. 11	47	11	Sept. 22	2	4	15	8
1875	Aug. 6	55	4	Sept. 19	4	3	18	9
1876	Jan. 29	51	9	Sept. 4	6	2	18	2
1877	Jan. 20	53	9	Oct. 9	3	3	15	0
1878	Dec. 15	41	4	Oct. 24	4	4	16	9
1879	Dec. 27	42	9	Oct. 23	2	6	14	6
1880	Feb. 17	53	2	Oct. 28	3	9	17	0
1881	Feb. 16	50	7	Sept. 18	1	11	16	11
1882	Feb. 21	58	7	Nov. 1	6	1	*a*22	1½
1883	Feb. 15	*b*66	4	Sept. 21	3	7	*a*19	5½
1884	Feb. 14	*c*71	0¾	...do	2	9	*a*17	4
1885	Jan. 20	46	0	Sept. 26	2	6	*a*15	7
1886	Apr. 9	55	9	Nov. 1	3	4	*a*17	10
1887	Feb. 5	56	3	Sept. 23	2	8	*a*15	1½
1888	Apr. 1	39	11	Aug. 7	5	3	*a*17	11
1889	Feb. 22	38	3	Sept. 13	5	3	*a*18	6
1890	Mar. 26	59	2	Aug. 30	5	9	*a*25	8
1891	Feb. 25	57	4	Oct. 7	4	5	*a*20	6
1892	Apr. 25	43	8	Nov. 5	3	5	*a*16	6
1893	Feb. 20	54	11	Aug. 30	3	7	*a*17	8
1894	Feb. 15	35	6	Sept. 14	3	1	*a*12	9
1895	Jan. 14	48	4	Oct. 28	2	3	*a*12	2
1896	Apr. 4	47	8.4	Sept. 25	5	6	*a*17	1.2

a Prepared from the stages as shown by the waterworks marks daily at 6 a. m. and 6 p. m., the previous years having been made from one daily observation at 6 a. m.
b Four o'clock to 5 o'clock a. m., inclusive.
c Twelve o'clock noon to 1.30 p. m.

MONTHLY COMPARISONS OF RIVER AND RAINFALL.

Highest, lowest, and average monthly stages of the Ohio River and the monthly and annual rainfall at Cincinnati in two years ending December 31, 1895 and 1896.

Month.	Highest.				Lowest.				Average.		Rainfall.	
	1896.		1895.		1896.		1895.		1896.	1895.	1896.	1895.
	Date.	Feet.	Date.	Feet.	Date.	Feet.	Date.	Feet.	Feet.	Feet.	Inches.	Inches.
January	1	24.8	14	48.4	21	7.6	6	8.8	14.1	28.8	1.49	6.13
February	9	33.10	1	16.2	29	12.4	8	10.4	23.6	13.3	1.56	.37
March	31	36.11	7	36.8	1	12.5	1	14.8	22.8	27.4	3.20	1.51
April	4	47.8	15	33.9	25	15.6	30	12	25.11	28.4	.59	2.62
May	9	17.9	21	17.2	26	7.10	31	10.8	12.2	12.8	2.17	1.83
June	30	23.8	1	10.1	3	8.10	29–30	4.6	11.10	6.5	2.70	2.15
July	29	40.9	28	12.5	9	9.10	1	4.6	22.2	7.6	7.40	2.27
August	2	41.9	1	9	31	9.8	18	5.1	19.10	6	3.70	3.29
September	30	9.9	1	6.5	25	5.5	30	3.9	6.8	4.10	5	.49
October	6	25.5	1–2	4.4	16	9.9	28	2.3	14.9	2.11	2.29	.73
November	30	21.5	23	5.4	8	9.8	1	2.4	13.8	3.5	3.29	4.66
December	2	29.11	31	21.8	31	10.2	1	4.5	16.7	9.6	1.09	3.29
For the year.	*a* 4	47.8	*b* 14	48.4	*c* 25	5.5	*d* 28	2.3	16.6	12.2	34.48	29.33

a April. *b* January. *c* September. *d* October.

SURVEY OF OHIO RIVER—MARIETTA TO PITTSBURG.

[Extract from report of Mr. R. R. Jones.]

Preparations for beginning the survey were made in the month of August, 1896.

Three parties were sent out to establish temporary water gauges between Davis Island Dam and Parkersburg. These gauges were established at points approximating the probable location of the additional locks and dams, and gauge readers secured to record the daily readings.

A quarter boat was built at Elizabeth, Pa., and fitted out at Pittsburg. This boat has a hull of the following dimensions: One hundred and ten feet long, 20 feet wide, with a depth of 3½ feet, and a draft, loaded, of 12 inches. Guards 2 feet wide extend along each side and capstans are provided at each end of hull. A lower cabin 82 feet by 20 feet and an upper cabin 62 feet by 17 feet are furnished with mess and bunk rooms, galley, wash rooms, drafting room, office, etc. This quarter boat was delivered at Pittsburg on September 16, 1896, eleven working days after it was begun at the shipyard at Elizabeth, Pa.

The entire party assembled at Pittsburg on September 17, 1896, and the quarter boat was taken down to Davis Island Dam on the same day, where some preliminary work had been done by the gauge parties on their return from setting the temporary gauges.

The work of the survey was carried on until November 30, 1896, when it was discontinued for the season, and the quarter boat was laid up at East Liverpool, Ohio, behind the ice piers at that point.

On June 21, 1897, the survey party assembled at Georgetown Island and work was resumed, in all branches, on the following day (June 22).

Previous to this some of the unfinished work of the season of 1896 was completed.

At the close of the fiscal year, June 30, 1897, the advance party of the survey (the main transit line) had reached station 53 miles + 400 feet below the Point Bridge, Pittsburg.

The progress of the work during the season of 1896 was greatly retarded by repeated rises of the river during the season of the year when lowest water stages usually prevail. The records for October, 1896, show the highest water for that month in thirty years.

The progress, therefore, during the season of 1897 was very satisfactory.

General scope of survey.—The survey includes longitudinal measurements of the river, cross sections and topography of banks and islands, precise levels (using elevations above mean sea level at Sandy Hook, New Jersey), and soundings; these latter on lines 400 feet apart.

At every mile a metallic bench mark, suitably numbered and carefully witnessed, is buried below the ground surface. The true elevation of these bench marks is established by the precise level and recorded. In addition to metallic bench marks, advantage is taken of culverts, prominent rocks, retaining walls, etc., to establish additional bench marks.

Water-surface elevations are taken by the cross-section level parties every 800 feet, and by the precise level party at every mile. Precise levels are run only between the hours of 9 a. m. and 3 p. m., in order to minimize the effect of rapid changes in temperature. The instrument is also shaded by a large umbrella.

The maximum variation allowed precise level running is one one-hundreth of a foot per mile run. In practice the average variation is about half this amount, and some miles are run with less than two one-thousandths of a foot per mile variation. The practice is to run forward and check back over the same course by the same party.

The bench from which the levels were started was that established by the Pennsylvania Railroad in 1888 on their office building at Tenth street and Penn avenue, Pittsburg. The levels which determine this bench were very carefully run by the Pennsylvania Railroad Company, and gave an elevation of 744.082 feet above mean tide at Sandy Hook, New Jersey. It is the intention to connect with the benches of the transcontinental line of levels run by the Coast and Geodetic Survey at Parkersburg, W. Va.

Results.—The data obtained by this survey will determine the number and location of the projected movable locks and dams between No. 6 (now partly completed) and Marietta, Ohio. By the building of these locks and the completion of the present project for Locks Nos. 2, 3, 4, and 5 slack-water navigation with a minimum stage of 6 feet will be obtained on the upper Ohio for a distance of about 171 miles from Pittsburg; that is, to Marietta, Ohio.

WORK AT MARIETTA ISLAND.

[Extract from report of Mr. Edmund Moeser.]

Back channel dam at head of Marietta Island.—An examination was made of this dam in July, 1896. The ice and floods during the preceding winter had carried out a section of the downstream slope about 85 feet in length and destroyed over 150 feet of the sheeting on lower apron. The remainder of the dam was in fairly good condition, except that some of the slope timbers were badly decayed and a few square yards of the paving had been displaced.

Repairs were made during August and September. The damaged slope was rebuilt and filled with 440 cubic yards of stone recovered from river bed below dam; the lower apron was resheeted with planking 2 inches thick, and all the worthless ties on the downstream slope were replaced with new timbers. The slope of the dam was repaved over an area of 1,755 square feet, and the joints over 4,345 square feet of the paving were grouted with Portland cement concrete.

The cost and amount of materials used in this work are as follows:

Stone (440 cubic yards)	
Timber (6,595 feet, B. M.)	$85.41
Driftbolts and spikes (2,227 pounds)	37.46
Cement (24 barrels)	51.60
Labor	270.38
Total	444.85

Protection dam at head of Marietta Island.—This dam was built in 1894, to stop the erosion at head of island caused by the action of the water pooled by the back-channel dam.

In the spring of 1896, it was found that the loose-stone top of the dam had been destroyed by ice and drift carried past the head of the island, and a project was submitted to rebuild the superstructure of stone covered with a layer of concrete. Approval having been received, the 225 feet of damaged dam was replaced, as indicated.

The cross section of the new work is approximately oval in shape, of 16 feet span, with a rise of about 4 feet. The concrete cover is from 9 to 12 inches in thickness with 1 inch facing. All the concrete, except that for the facing, was made with unscreened sand and gravel taken from the bar in the vicinity of the work. It was mixed in the proportion of 1 part Portland cement to 9 parts sand and gravel. The facing was of 1 part cement to 2 parts sand.

Additional shore protection was placed around the root of dam on island. A large washout in the bank just below dam was filled with material taken from the bar and covered with a layer of brush and stone.

The following is a statement of the material expended and cost of the work:

Stone (420 cubic yards)	$373.80
Cement (136 barrels)	292.40
Lumber, for molds, etc. (464 feet B. M.)	6.96
Labor-shaping stone, mixing concrete, and placing shore protection	367.02
Miscellaneous—freight and traveling expenses	23.20
Total	1,063.38

Protection work on right bank of river, opposite head of Marietta Island, to stop erosion.—This work was in accordance with instructions received, and consisted in building 3 short, loose-stone spur dikes, and placing a covering of brush and stone over the foot of the caving bank, between and around the dikes. The work extends over a distance of 700 feet, and was completed during the month of November, 1896.

The dikes as built are not an obstruction to navigation, as they do not extend out beyond the former line of bank. A recent examination shows that the work has been beneficial to the bank and will doubtless prevent further caving.

The following is a statement of the material expended and cost of the work:

Stone (1,557 cubic yards)	$1,385.73
Brush (140 cords)	63.00
Labor-shaping dikes, and shore protection	187.68
Incidentals—traveling expenses	8.45
Total	1,644.86

WORK OF THE OHIO RIVER DREDGES DURING THE CALENDAR YEAR 1896.

[Extract from the report of Mr. E. J. Carpenter.]

It has been customary to put the dredging fleet, which consists of 2 dredges, 4 dump scows, and a decked flatboat, in as good order as possible each year before beginning operations; but since 1893, when the last thorough repairs were made, the pressure of work has been such that the required time could not be spared, and consequently all refitting had been postponed, except that necessary to keep the boats from breaking down entirely.

This was especially unfortunate, because the work done by the boats had been very heavy, about 35 per cent of the 474,000 cubic yards excavation made during the past three years being loose rock, cemented gravel, etc., in addition to many large rocks, wrecks, and snags removed.

The plant had, in consequence, seriously deteriorated, making extensive repairs a necessity.

The fleet was brought to Cincinnati and repairs were begun on March 16, 1896.

During the low-water work at Guyandotte Bar, in 1895, the dredge *Ohio* had two of the bottom plates cut through by rocks, making it necessary to replace them. The dredge had never been docked or taken out of the water since the iron hull was built in 1880, and until these plates were broken had never had a leak in the bottom plating, though subjected to severe pounding over rough and rocky bars. On taking the boat out on the ways, the hull was found to be in very good condition, though many of the plates were pitted to a depth of about one-eighth of an inch.

It was expected that the *Ohio's* crane, which had been in service since 1876, could be patched up to stand another year, but on taking it down the breaks were found to be past repair, and as a new crane had to be built, advantage was taken of the unavoidable delay to remodel the machinery and hull, substituting wire ropes for all chains, and arranging to hold the dredge up on the spuds while at work. Owing to delays at the shops and in delivery of the new machinery and crane the dredge was not ready for operation until the latter part of October.

The *Ohio*, as now fitted, has hoisting drum with steel gears and clutch, dipper and independent swinging cylinder, built by the Bucyrus Steam Shovel and Dredge Company, of Milwaukee. The forward spuds are of Washington fir, 20 inches square, 38 feet long, which are operated by engines driving wire ropes so arranged as to either hoist the spuds or to hold the dredge up while at work. Independent engines were also put in to hoist the aft spud, a new roof of steel plates was built over the forward half of the boat, and additional rooms were built for accommodation of the crew. The cost for repairing and remodeling the dredge hull, building new crane, dipper, spuds, and machinery, and fitting up ready for work, was $12,500. This amount has not been taken into account in the statement of cost of work in 1896, because it is not properly chargeable to any one year.

The dredge has been tried only on the cemented gravel bar at Craigs for a short time, but the improvement in effectiveness and in speed of operation is very evident. The dredge would do much better work, especially in the cemented gravel, with increased power, which can be best obtained by putting on larger cylinders for the main engines.

A lock for the crane is required, and some slight modifications at other points, as suggested by the trial of last season.

The *Oswego* was fitted with new dipper and pole, larger forward spuds, and new nosing for the hull, besides receiving a general overhauling of machinery.

Three of the dump scows were taken out on the ways and received extensive repairs, replacing most of the bottom planking and renewing a number of side planks that had rotted.

On completion of the *Oswego's* repairs, the dredge was sent to widen the channel at Cullums Ripple, and afterwards to Wheeling Creek and Craigs Bar.

The season of 1896 was one of very unusually high water, the river being low enough for dredging only for a period of less than two months.

Cullums Ripple, 471.5 miles below Pittsburg.—The *Oswego* was employed to widen the channel at this point, which was done by removing a part of the gravel bar on the right of the channel at the foot. The work was not more than fairly begun before it was interrupted by high water, and before the river fell enough to resume it became necessary to send the dredge to Wheeling Creek.

Excavation made June 22–27.

	Cubic yards.
Gravel and sand	3,022

Wheeling Creek Bar, 90.5 miles below Pittsburg.—A sudden rise of Wheeling Creek to an unusual height in July carried away the Baltimore and Ohio Railroad Bridge and a portion of the railroad depot at the mouth of Wheeling Creek, and the débris deposited in the Ohio River at this point built up the bar so as to almost close the channel, making it impossible for coal tows to pass.

The bar was dredged by the *Oswego*, but owing to the high stage of river during the work the bar was not removed to below the ordinary low-water channel depth, thus leaving about 5 feet which should be dredged off at the first opportunity.

Excavation made July 13 to August 22.

Loose rock, gravel, etc. . . . cubic yards	14,179
Large rocks removed (weighing 5 tons)	2

Craigs Bar, 537.5 miles below Pittsburg.—The object of dredging at this place was to open a new, straight channel on the Kentucky side of the main bar, supplementing the work of the dikes then under construction, for the purpose of closing the crooked channel along the Indiana shore.

The work was begun on August 31, by the *Oswego*, and a small dredge hired from William A. Kirk, and was continued until interrupted by high water on October 3. On November 6, when the river had again become low enough to permit dredging, the work was resumed by both the Ohio River dredges and the Kirk dredge. Operations were continued, with some interruption from high water, until November 27, when the river again rose, and as there was no prospect of a fall that would permit early resumption, the boats were sent into winter quarters.

The length of channel dredged was 3,800 feet, the upper end for a distance of about 1,000 feet being gravel and sand, but for the remaining distance the cuts were made through cemented gravel. For about 800 feet the cemented gravel was found in layers from 6 to 30 inches thick, and so hard that the power of the dredges was barely sufficient to break it.

For about 2,000 feet at the lower end the cemented gravel was much less refractory, the dredge dippers making rapid progress through most of it. The dredging at Craigs opened a channel with about 90 feet minimum width at the highest part of the bar, which is about one-half the space required for the safe passage of boats.

Excavation made August 31 to November 27.

	Cubic yards.
Cemented gravel	31,788
Gravel and sand	4,218
Total	36,006

* * * * * * *

Supplemental to my report for the calendar year 1896 is the following statement of dredging in 1897, up to the close of the fiscal year:

The Ohio River dredges remained in winter quarters in the Kentucky River until March 7, when they were brought to Cincinnati for annual repairs, preparatory to resumption of dredging at Craigs Bar.

Owing to continued high water, the dredges remained at Cincinnati until May 26, when, as there was no immediate prospect of a stage of river suitable for work at Craigs, they were taken up the river to Guyandotte Bar.

Guyandotte Bar, 303 miles below Pittsburg.—When the system of dikes at this place was built in 1895, a channel 125 feet wide was dredged through the bar for a distance of about 1,350 feet. This channel was too narrow for ascending tows during the lower stages of river and also for descending packets, which, having a crossing just before entering the channel, could not always make the turn.

The dredging during the past month has resulted in widening the channel to 250 feet for a distance of 1,500 feet, giving safe passage for packets and tows at all stages.

Excavation made June 1 to 29.

	Cubic yards.
Hard gravel with shale and bowlders	23,491

Ohio River dredging statement for 1896.

[Exclusive of time spent in remodeling dredge Ohio, June 21 to November 8.]

DREDGES IN COMMISSION.

TIME.

Time at work.	Days.	Time lost.	Days.
Dredging cemented gravel	15.7	Sundays	24
Dredging loose rock, gravel, etc	8.6	High water	29
Dredging gravel and sand	4.7	Accidents	13.3
Removing rocks	.1	Traveling	7.6
		Holidays	3
Total	29.1	Total	76.9

Total in commission, 106 days.

WORK.

Nature of work.	Per day of work.	During season.
	Cu. yds.	*Cu. yds.*
Cemented gravel excavated	2,024.7	31,788
Loose rock, gravel, etc., excavated	1,648.7	14,179
Gravel and sand excavated	1,540.4	7,240
Total excavation for the season		53,207

Rocks removed (weighing 5 tons), 2.

COST FOR SEASON.

Equipment	$1,123.77
Towing and fuel	4,809.24
Repairs	173.41
Salaries	3,794.17
Total	9,900.59

DREDGES OUT OF COMMISSION.

TIME.

	Days.
In ordinary	104
Annual repairs	99
Total	203

COST.

Salaries in ordinary		$1,759.44
Salaries during annual repairs	$4,726.05	
Annual repairs (shop bills, materials, etc.)	4,171.03	
Total cost of repairs		8,897.08
Total out of commission		10,656.52
Cost per day in ordinary (including superintendent's pay)		16.92

COST OF WORK, INCLUDING ALL EXPENDITURES, IN 1896.

[With exception of remodeling dredge Ohio.]

Dredging cemented gravel	$11,090.95
Dredging loose rock, gravel, etc	6,075.30
Dredging gravel and sand	3,320.22
Removing rocks	70.64
Total expenditure in 1896	20,557.11

COST PER UNIT.

Per cubic yard of excavation	$0.386

Location and description of work.

Place.	From Pittsburg.	Date.	Days of work.	Kind of work.	Rocks.	
					No.	Tons.
	Miles.	1896.				
Cullums Ripple	471.5	June	2.2	Dredging gravel and sand		
Wheeling Creek Bar	90.5	July to Aug	8.6	Dredging loose rock, gravel, etc		
Do	90.5	do	.1	Removing rocks	2	5
Craigs Bar	537.5	Aug. to Nov.	15.7	Dredging cemented gravel		
Do	537.5	Nov	2.5	Dredging gravel and sand		
Total			29.1		2	5

Place.	Excavation.				Expenditures.				
	Cemented gravel.	Loose rock, gravel, etc.	Gravel and sand.	Per day of work.	Removing rocks.	Dredging cemented gravel.	Dredging loose rock, gravel, etc.	Dredging gravel and sand.	Total for 1896.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*					
Cullums Ripple			3,022	1,373.6				$1,554.15	$1,554.15
Wheeling Creek Bar		14,179		1,648.7			$6,075.30		6,075.30
Do					$70.64				70.64
Craigs Bar	31,788			2,024.7		$11,090.95			11,090.95
Do			4,218	1,687.2				1,766.07	1,766.07
Total	31,788	14,179	7,240		70.64	11,090.95	6,075.30	3,320.22	20,557.11

Commerce of Ohio River in 1896.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
Coal shipments from Pittsburg.	Pittsburg to Cairo	965	9	4,102,190	....
McKinley Coal Co	.....do	965	8	158,800	....
Gray's Iron Line	.....do	965	6	15,050	....
Huntington & St. Louis Towboat Co.	.....do	965	9	117,660	....
Steamer Belle Prince	.....do	965	8	28,000	....
A. Montgomery & Co	Pittsburg to Paducah	919	11	552,400	....
Relief Towboat Co	Pittsburg to Louisville	598	12	70,500	....
Steamer Adelle	.....do	598	5	45,490	....
Steamer Geo. W. Moredock	.....do	598	9.5	60,000	....
Steamer Virginia	Pittsburg to Cincinnati	467	10	29,400	12,691
Steamer Keystone State	.....do	467	10	32,000	8,600
Steamer Hudson	.....do	467	8	20,370	3,664
Steamer Elaine	.....do	467	7	12,374	419
Hulings Bros	.....do	467	5	4,188	....
Steamer Argand	Pittsburg to Gallipolis	267	4	2,553	2,700
Steamer H. K. Bedford	Pittsburg to Point Pleasant	263.5	11	7,523	6,948
Steamer Kanawha	.....do	263.5	4	4,026	1,998
Steamer Ruth	.....do	263.5	10	9,425	10,550
Belmont Coal Co	Pittsburg to Middleport	249.5	6	20,000	....
Steamer D. T. Watson	Pittsburg to Parkersburg	183	3	26,528	....
Steamer Catherine Davis	.....do	183	5	179,800	....
Steamer Ben Hur	.....do	183	10	8,976	8,280
Steamer Bob Ballard	.....do	183	5	15,114	....
Steamer Lorena	Pittsburg to Marietta	171	10	8,000	7,500
Steamer Enos Taylor	Steubenville to Cincinnati	400	6	10,000	3,000
Steamer Gate City	Wheeling to Cairo	875	9	150,000	....
Steamer Coal Bluff	.....do	875	12	96,000	....
Steamer Liberty	Wheeling to Parkersburg	93	7	4,000	14,503
Steamer Leroy	.....do	93	2	3,000	963
Steamer Lexington	Wheeling to Matamoras	51	11	6,000	8,500
Steamer Jewel	Wheeling to Clarington	27	11.5	2,000	12,600
Steamer Rob Roy	Bellaire to Marietta	77	7	18,000	5,200
Steamer T. N. Barnsdall	Matamoras to Marietta	32	10	7,500	12,400
Steamer Columbia	Marietta to Point Pleasant	92.5	11	15,122	4,225
Steamer Valley Belle	Marietta to Middleport	78.5	10	4,396	2,709
Steamer New Haven	Parkersburg to Louisville	415	12	28,761	....
Jas. R. Ware	Parkersburg to Cincinnati	284	12	18,265	....
Steamer Nellie Bartlett	Parkersburg to Middleport	66.5	4	1,283	....
Steamer M. P. Wells	Ravenswood to Augusta	206	10	14,000	20,560
Steamer Little Queen	Millwood to Middleport	20	1	200	1,800
The Jessie Towboat Co	Syracuse to Carrollton	299	10	56,000	....
Steamer Mary L. Hatcher	Syracuse to Gallipolis	24	10	410	1,800
John Barrett & Son	Pomeroy to Cairo	717	12	55,500	....
Steamer Lee H. Brooks	Pomeroy to Louisville	350	6	13,300	13,391
Steamer Mary F. Golden	Pomeroy to Cincinnati	219	6	3,000	3,000
Cincinnati, Portsmouth, Big Sandy and Pomeroy Packet Co.	.....do	219	11	122,875	38,095
The Marmet Co	Point Pleasant to Louisville	335	11	86,453	....
Pomeroy, Cincinnati and Louisville Barge Line.	.....do	335	4.5	186,500	....
Ella Layman Towboat Co	Point Pleasant to Cincinnati	203	7	76,770	....
Kanawha and Ohio Transportation Co.	.....do	203	5	301,306	....
Armstrong Bros	.....do	203	5	40,000	....
Steamer Crown Hill	.....do	203	12	85,500	....
Steamer Claribell	Point Pleasant to Gallipolis	4	10.5	3,700	5,341
Steamer Carrie Brown	Gallipolis to Huntington	39	10	5,260	12,850
Steamer Vesper	.....do	39	9	3,500	13,000
Steamer Chevalier	Proctorville to Portsmouth	51	11	6,521	7,622
Big Sandy Towboat Co	Guyandotte to Louisville	295	6	320,000	....
Steamer J. H. McConnell	.....do	295	13	192,175	....
Steamer Lucy Coles	Huntington to Portsmouth	47	12	6,000	....
Steamer Georgia	Huntington to Ironton	19	4	1,150	3,126
Zuhars Bros	Huntington to Louisville	270.5	10	9,452	....
Steamer Silver Wave	Portsmouth to Augusta	70.5	10	1,800	15,000
Buena Vista Freestone Co	Buena Vista to Cincinnati	95.5	9	12,500	....
John A. Borches	Manchester to Carrollton	147	11	8,500	....
James Tucker	Manchester to Vevay	139	12	6,000	....
Smith Coal and Sand Co	Manchester to Addyston	86	10	60,000	....
Steamer Henrietta	Maysville to Cairo	560	8	....	9,500
Steamer Island Queen	Maysville to Aurora	88	[a]6	15	5,376
Steamer Tacoma	Chilo to Cincinnati	35	10	6,720	11,600
Steamer John Mackey	New Richmond to Vevay	87	12	828,166	....
Steamer Alice L. Barr	New Richmond to Aurora	47	12	257,400	....

[a] Days.

Commerce of Ohio River in 1896—Continued.

Name of boat or company.	Terminal points.	Distance.	In commission.	Freight.	Passengers.
		Miles.	*Months.*	*Tons.*	
The Coney Island Co.	Coney Island to Cincinnati	10	4	700	418, 646
Henry Spillie & Son	Dayton to Cincinnati	3	10	6, 000	....
R. H. Fleming	Newport to Ludlow	3	12	....	....
Steamer F. J. O'Connell	Cincinnati to Cairo	499	8	25, 000	....
New Orleans and Cincinnati Packet Co.	.....do	499	9	54, 382	5, 863
Memphis and Cincinnati Packet Co.	.....do	499	10	41, 705	5, 159
Louisville and Cincinnati Packet Co.	Cincinnati to Louisville	132	11	146, 225	103, 095
Steamer Huston Combs No. 2.	.....do	132	3	38, 750	....
Steamer Jim Montgomery	.....do	132	8	32, 000	1, 000
Steamer Levi J. Workum	Cincinnati to Vevay	66	12	10, 301	3, 035
Steamer Swan	Aurora to Rising Sun	10	12	243	1, 100
Steamer Rescue	Carrollton to Louisville	57	12	10, 000	2, 456
Steamer Falls City	.....do	57	8	12, 150	4, 863
Steamer Little Sandy	Carrollton to Madison	12	2	100	35
Louisville and Jeffersonville Ferry Co. (excursion).	Madison to Leavenworth	105	4	....	235, 741
Steamer Charley Boy	Madison to Louisville	45	9	150	....
Steamer D. A. Nesbit	Louisville to Cairo	367	8	15, 250	1, 250
Bergenroth Bros	.....do	367	12	24, 500	....
Steamer Little Albert	.....do	367	4	2, 100	....
Louisville and Evansville Mail Co.	Louisville to Henderson	197	12	86, 291	28, 433
Steamer S. D. Blair	Louisville to Evansville	185	12	22, 000	....
Steamer Raymond	Louisville to Stephensport	97	12	5, 232	100
Steamer G. B. Monteith	Cloverport to Evansville	78	4	5, 000	1, 000
Steamer Jack Osborn	Cannelton to Shawneetown	131	11	200, 000	....
Steamer Gertrude	Cannelton to Owensboro	32	12	7, 725	20, 658
Steamer Herbert Moran	Owensboro to Paducah	171	12	9, 115	....
Steamer Racket	Newburg to Shawneetown	78. 5	7	6, 458	....
Steamer Little Clyde	Mouth Green River to Evansville.	8	12	5, 100	....
Steamer I. N. Hook	.....do	8	5	29, 401	....
Steamer Gayoso	.....do	8	[a] 8	200	105
Steamer T. C. Woodward	.....do	8	3	50	990
Steamer W. T. Norton	.....do	8	0. 5	10	140
Steamer Lela	.....do	8	7	220	2, 664
Steamer Fawn	.....do	8	0. 5	20	330
Steamer Maggie Belle	Evansville to Cairo	182	1	900	....
Steamer John F. Buckham	Evansville to Metropolis	146	4	1, 885	4
Steamer John S. Hopkins	Evansville to Paducah	137	12	12, 500	7, 037
Steamer Joe Fowler	.....do	137	12	8, 876	5, 492
Nashville and Paducah Packet Co.	.....do	137	6	6, 400	3, 700
Steamer Jewel	Evansville to Henderson	12	12	6, 200	26, 720
Steamer Penguin	Mouth Wabash River to Cairo.	127	12	18, 632	....
Steamer Emma Cooper	Shawneetown to Cairo	117	12	42, 662	....
Steamer Dick Clyde	Caseyville to Brooklyn	63	6	8, 461	....
Steamer John L. Lowry	Elizabethtown to Cairo	88	12	26, 200	6, 219
Steamer Peter Houtz	Smithland to Cairo	57	10	17, 500	1, 500
Steamer Dick Fowler	Paducah to Cairo	45	12	10, 400	15, 600
St. Louis and Tennessee River Packet Co.	.....do	45	12	40, 567	5, 100
Steamer John D. Lewis	.....do	45	11	248, 841	....
Steamer Geo. H. Cowling	Paducah to Metropolis	9	12	2, 666	25, 750
Total	....	....	....	9, 914, 435	1, 223, 296

[a] Days.

According to reliable information furnished this office by persons interested in river commerce, no new lines of transportation have been established during the year.

River commerce of Cincinnati for the year ending December 31, 1896.

Articles.	Receipts.	Shipments.	Total.	Articles.	Receipts.	Shipments.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
Alcohol		10	10	Lead, white		539	539
Ale, beer, and porter	2	1,690	1,692	Leather	274	128	402
Apples, green	2,311	579	2,890	Lemons	1	126	127
Bagging	56	33	89	Lime	590	522	1,112
Barley	2	6	8	Lumber	14,750	6,300	21,050
Beans	108	185	293	Malt	3	77	80
Beef	1	4	5	Manufactures, sundry		506	506
Boots and shoes	75	390	465	Merchandise	22,019	23,431	45,450
Bran, middlings, etc	236	235	471	Molasses	5,072	1,397	6,469
Broom corn	1	3	4	Nails	4,192	3,876	8,068
Butter	170	30	200	Oats	61	224	285
Candles		52	52	Oil	567	717	1,284
Castings	1,177	878	2,055	Onions	73	252	325
Cattle	3,295	130	3,425	Oranges	2	169	171
Cement and plaster	980	940	1,920	Peanuts	46	337	383
Cheese	2	65	67	Petroleum	177	1,281	1,458
Cider	200	178	378	Potatoes	2,120	1,397	3,517
Coffee	7	833	840	Rice	507	73	580
Cooperage	985	1,752	2,737	Rope, twine, etc	3,428	2,971	6,399
Corn	764	136	900	Rosin	25	111	136
Corn meal		150	150	Rye	152	44	196
Cotton	17,399	15	17,414	Salt	16,431	9,941	26,372
Crockery	49	169	218	Seed, clover and timothy	352	1,396	1,748
Eggs	744	41	785	Sheep	1,150		1,150
Feathers	63	8	71	Shot		107	107
Fish	112	378	490	Soap	74	363	437
Flour	1,137	2,142	3,279	Sorghum	321	70	391
Fruit, green	3,248	1,290	4,538	Spices	6	14	20
Fruit, dried	205	71	276	Starch		166	166
Furniture		586	586	Sugar	854	2,485	3,339
Glass, window	114	57	171	Tallow	187	19	206
Glassware	2,041	2,234	4,275	Tobacco, leaf	15,760	2,169	17,929
Grease	457	95	552	Tobacco, manufactured	41	258	299
Hardware	458	2,706	3,164	Turpentine		16	16
Hay	4,186	462	4,648	Vegetables, green	450	766	1,216
Hides	446	140	586	Vinegar		1,188	1,188
Hog products	42	2,678	2,720	Wheat	985	884	1,869
Hogs	8,794	10	8,804	Whisky	5,664	3,122	8,786
Hops	1	14	15	Wines and liquors	125	343	468
Horses	708	778	1,486	Wool	116	52	168
Iron and steel	12.726	7,981	20,707	Yarn, cotton	401		401
Iron and steel, scrap	543	30	573				
Iron, pig	157	95	252				

RECAPITULATION.

	Tons.
Receipts	160,978
Shipments	98,096
Total	259,074

Coal shipments from Pittsburg, Pa.

[Furnished by Capt. William Evans.]

Month.	To Cincinnati.				To Louisville.			
	Trips.	Coal boats.	Coal barges.	Tons.	Trips.	Coal boats.	Coal barges.	Tons.
1896.								
January	56	44	271	151,460	70	189	140	260,137
February	65	84	394	299,825	78	200	160	307,100
March	75	80	396	324,960	60	300	70	365,029
April	58	115	559	390,392	72	344	605	588,875
May	32	31	363	217,463	35	165	284	296,215
July	11	23	63	58,727	6	28	26	42,425
October	21	7	242	108,600	13	32	116	92,070
November	44	25	111	103,850	66	64	125	143,325
December	62	35	176	154,488	75	104	245	197,229
Total	424	444	2,575	1,809,785	475	1,426	1,771	2,292,405
Grand total								4,102,190

NOTE.—No shipments in June, August, and September.

Comparative table showing coal shipments from Pittsburg during the ten years ending December 31, 1896.

Year.	To Cincinnati.	To Louisville.	Total.	Year.	To Cincinnati.	To Louisville.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1887	788.690	1,367,012	2,155,702	1892	914,430	1,384,864	2,299,294
1888	1,950,882	2,223,494	4,174,876	1893	829.878	1,534,523	2,364,401
1869	1,149,892	1,439,747	2,589,639	1894	1,153,765	1,800,022	2,453,787
1890	1,324,641	2.095,716	3,420,357	1895	1,036,661	1,357,212	2,393,873
1891	1,065,705	1,828,047	2,893,752	1896	1,809,785	2,292,405	4,102,190

Commerce passing Davis Island Dam in 1896.

Vessels.	Ascending.				Descending.				Total freight.
	Through lock.		Through pass.		Through lock.		Through pass.		
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*Tons.*
Packets	69	6,715	265	24,745	78	6,770	257	28,046	66,276
Towboats	293	....	1,326	....	210	....	1,878	....	....
Model barges	24	1,800	42	....	....	....	52	29,800	31,600
Coal boats	158	....	566	....	....	....	1,557	1,401,300	1,401,300
Barges	668	700	3,301	22,195	15	6,430	3,835	1,976,859	2,006,184
Flats	405	5,950	1,124	10,592	217	17,738	1,676	220,176	254,456
Rafts	....	....	....	....	1	800	21	51,143	51,943
Miscellaneous	58	....	153	....	73	....	170	....	....
Total	1,675	15,165	6,777	57,532	589	31,738	8,946	3,707,324	3,811,759

Commerce passing Dam No. 6 in 1896.

Vessels.	Ascending.		Descending.		Total freight (tons).
	Number.	Tons.	Number.	Tons.	
Packets	333	31,810	336	36,116	67,926
Towboats	1,194	....	1,103	....	....
Model barges	63	....	59	35,400	35,400
Coal boats	671	....	1,452	1,324,224	1,324,224
Barges	3,738	....	3,639	1,935,948	1,935,948
Flats	920	35,620	929	140,636	176,256
Rafts	....	....	9	20,200	20,200
Light flats	133	....	151	....	....
Miscellaneous	29	....	26	3,380	3,380
Total	7,081	67,430	7,704	3,495,904	3,563,334

Comparative statement of commerce passing the Falls of the Ohio River by canal and by river.

Year.	Canal.		Open river.		Total.	
	Vessels.	Tons.	Vessels.	Tons.	Vessels.	Tons.
1882	3,988	935,628	2,305	668,866	6,293	1,604.494
1883	5,231	1,349,115	1,484	483,281	6,715	1,832,396
1884	3,485	785,192	1,548	484,124	5,033	1,269,316
1885	5,678	1,443,181	822	262,862	6,500	1,706.043
1886	4,964	1,240,112	1,796	577,547	6,760	1,817,659
1887	4,069	867,807	2,297	1,204,518	6,366	2.072,325
1888	6,963	1,915,365	2,252	1,162.305	9,215	3,077,670
1889	5,534	1,404,573	1,984	957,829	7,518	2,362,402
1890	4,386	998,062	3,828	1,717.158	8,214	2,715,220
1891	4,739	1,302,471	2,137	1,062,428	6,876	2,364,899
1892	5,506	1,275,329	1,826	858,953	7,332	2,134,282
1893	3,902	848,211	1,722	514,317	5,624	1,362,528
1894	5,280	1,245,899	461	149,937	5,741	1,395,836
1895	3,921	859,491	945	316,269	4,866	1,175,760
1896	6,046	1,542,347	1,426	436,955	7,472	1,979,302

Number of steamers in the freight and passenger traffic between Cincinnati and other ports, and total tonnage, compared for ten years.

Year.	Number.	Tonnage.	Year.	Number.	Tonnage.
Fiscal year.			*Calendar year.*		
1886-87	48	23,268	1893	36	22,569
1887-88	48	24,348	1894	34	20,527
1888-89	42	24,453	1895	30	18,587
1889-90	48	23,583	1896	25	15,032
1890-91	37	24,145			
1891-92	40	23,374			

List of Ohio River steamers destroyed in the year 1896, causes of destruction, and tonnage represented.

Name.	How destroyed.	Tonnage.
Congo	Sunk	509.18
Florence Shanks	Burned	39.34
Buckeye Boy	do	126.00
Vesper	Destroyed by ice	73.64
John D. Lewis	Burned	266.41
Sam Brown	do	474.10
Total tonnage destroyed		1,578.67

Annual arrivals and departures of steamers at Cincinnati for years indicated.

Year.	Arrivals.	Departures.	Year.	Arrivals.	Departures.
Fiscal year.			*Fiscal year*—Continued.		
1872-73	2,340	2,333	1886-87	2,272	2,281
1873-74	2,596	2,600	1887-88	2,113	2,115
1874-75	2,602	2,665	1888-89	2,521	2,522
1875-76	2,779	2,808	1889-90	2,257	2,252
1876-77	2,646	2,653	1890-91	2,234	2,234
1877-78	2,942	2,942	1891-92	2,185	2,188
1878-79	2,725	2,730			
1879-80	3,163	3,167	*Calendar year.*		
1880-81	2,633	2,633			
1881-82	2,739	2,736	1892	2,052	2,062
1882-83	2,340	2,329	1893	1,891	1,894
1883-84	2,170	2,162	1894	1,687	1,694
1884-85	2,137	2,138	1895	1,028	983
1885-86	2,489	2,483	1896	1,124	1,042

Arrivals and departures of steamboats at the port of Cincinnati, Ohio.

Year.	Arrivals.				Departures.			
	From New Orleans.	From Pittsburg, Pa.	From other ports.	Total.	For New Orleans.	For Pittsburg.	For other ports.	Total.
Fiscal year.								
1887-88	35	156	1,389	1,580	37	153	1,385	1,575
1888-89	51	237	2,233	2,521	51	237	2,234	2,522
1889-90	38	197	2,022	2,257	37	194	2,021	2,252
1890-91	31	208	1,995	2,234	31	207	1,996	2,234
1891-92	23	204	1,958	2,185	23	202	1,963	2,188
Calendar year.								
1892	20	186	1,846	2,052	22	185	1,854	2,062
1893	17	120	1,754	1,891	17	120	1,757	1,894
1894	26	100	1,561	1,687	25	102	1,567	1,694
1895	24	*a* 52	952	1,028	26	*a* 46	911	983
1896	21	*a* 106	997	1,124	24	*a* 111	967	1,042

a Includes Wheeling, W. Va.

Schedule of rates on flour per barrel by rail and river from Cincinnati for ten years ending December 31, 1896.

Year.	To Pittsburg.		To Louisville.		To New Orleans.		To Memphis.	
	By rail.	By river.	By rail.	By river.	By rail.	By river.	By rail.	By river.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1887	24–31	15	15	15	44–49	35	....	....
1888	22–24	15	15	15	40–49	35	....	....
1889	23	15	15	15	54	35	....	....
1890	23–24	15	15	15	49–54	35	....	....
1891	24	15	15	15	49	35	....	....
1892	24	15	15	15	49	35	40	30
1893	24	15–20	15	15–10	49	35–30	40	30–40
1894	24	20	15	10	49	40	40	30
1895	20–24	20	15	10	49	40	40	30
1896	20–22	20	15	10	49	40	40	30

C C 2.

OPERATING SNAG BOAT ON THE OHIO RIVER.

The act of Congress making a yearly appropriation of $25,000 for this work is quoted in the Annual Report for 1896, part 4, page 2093, which also states the object of the work, and the probable greater efficiency secured by the river and harbor act of 1896, which increased the amount available yearly from $25,000 to $50,000.

The repairs of the snag boat *E. A. Woodruff* were completed in June, 1896, at Cincinnati, where she remained until July 15 awaiting availability of funds; on that date she started to Pittsburg direct and then worked downstream to Fish Creek Island, 113 miles below. A rise permitted return up river to Bellaire, but the water was then too high for work, and on August 6 she went on to Wheeling for stores and then proceeded downstream, removing obstructions en route, arriving at Cairo, Ill., September 2. The upstream trip was begun next day; four days were spent at Craigs Bar removing 75 snags, etc., from the channel; repairs to paddle wheels detained her at Cincinnati five days; she again went direct as far up as Short Creek, 81 miles below Pittsburg, where it was learned that the channel was clear above. As the river was falling, she worked downstream until reaching South Point, 314 miles below Pittsburg. At this place the starboard rudder was badly damaged, compelling her return to Cincinnati. On October 27 the *Woodruff* started down river, working as far as Evansville. No obstructions being reported below, she ascended the river, working en route, until within 56½ miles of Pittsburg, and there removed a coal-barge wreck. No work being required above that point, she hastened to Williamsons Island, 77 miles below, where a wreck menaced coal fleets under way down. After removal of this obstruction she performed her regular work as far down as Kentucky River, and on December 7 went into her regular winter quarters in the mouth of that stream.

On March 7, 1897, the snag boat was brought to Cincinnati, having in tow all the Government boats from this district harbored in the mouth of the Kentucky, to undergo the regular spring repairs, which are always necessary to fit her for effective work after the hard service of the previous season. This spring the repairs were quite extensive, as the boat had never been thoroughly overhauled since put in commission in 1876, and many desirable changes and improvements had been postponed owing to lack of funds, or opportunity to make them without neglecting important work on obstructions. The increased appropriation for snag-boat work will afford the funds for these improvements. Repairs were made to the wheels, engines, boilers, furnaces, steam pipes, wrecking machinery, cabin, etc. Some betterments were also placed, including a steam-heating plant to avoid fire risk, an electric storage battery, and new steel wrecking hook.

The repairs were completed May 21, and the boat went direct to Beaver Dam, 29½ miles below Pittsburg. As the river was falling, she began operations downstream. On June 7 she reached Cincinnati and remained in port until the 16th, repairing wrecking hook and hull, both of which had been damaged on the trip. The down-river trip was then resumed as far as Evansville, but as high water made it unnecessary to go below, the boat returned upstream, and on June 30 was at Madison, Ind., 553 miles below Pittsburg.

During the fiscal year the *Woodruff* traveled 7,037 miles and removed the following obstructions: 805 snags, 62 wrecks, 154 cubic yards rock, and 166 trees.

The snag boat is under the capable management of Mr. W. H. Christian, extracts from whose reports are appended, giving in detail the operations during the year.

The itemized statement of expenses, required by section 13, river and harbor act of September 19, 1890, is below.

In addition to the work of the snag boat, it sometimes happens that boats are wrecked or that snags or other obstructions unexpectedly appear in the channel when she is too far distant to be available, and the danger to be apprehended will not permit of delay. In such cases local wrecking companies or other means are employed and the expense borne by the snag-boat appropriation.

During the year the following wrecks were removed under these conditions:

Deadmans Island, 12½ miles below Pittsburg.—Wreck of a coal flat at this locality which had drifted into a landing, opposite the village of Sewickley, frequently used by coal tows when overtaken by fog, storms, etc.

Cost of removal:

Hire of steamboat	$32.50
Explosives	65.54
Total	98.04

Browns Island, 62 miles below Pittsburg.—Two coal-boat wrecks and a large rock in the channel, the cost being as follows:

Hire of steamboat	$76.00
Explosives	88.00
Total	164.00

Cincinnati, 467 miles below Pittsburg.—On January 2, 1897, the high water which had prevailed in December fell to a 10-foot stage, exposing a dangerous coal-boat wreck at the landing directly in the channel path of all steamers, which, if the river continued to fall, would not leave room for safe passage on either side, and in case of another rise would be again hidden and liable to wreck other vessels. In the emergency bids were asked by telephone from four wrecking companies, and the obstruction removed in three days, at a cost of $65.

Itemized statement of expenses for operating snag boat on the Ohio River, and removing snags, wrecks, and other obstructions in said river.

Month.	Pay of crew (labor).	Subsistence.	Fuel.	Miscellaneous supplies (hire).	Tools and implements.	General repairs and betterments.	Contingent expenses.	Total.
1896.								
July	$1,337.79	$324.87	$300.13	$32.98	$0.35	$798.93	$20.75	$2,815.80
August	2,001.33	533.16	242.15	281.96	6.42	1,557.84	14.60	4,636.96
September	1,968.93	348.37	141.09	11.01	....	10.58	....	2,479.98
October	1,978.77	640.83	324.38	173.23	16.98	140.99	1.60	3,276.78
November	2,018.58	286.37	306.16	28.38	....	15.00	6.15	2,660.64
December	887.13	98.17	107.61	18.64	....	....	66.85	1,178.40
1897.								
January	400.00	10.06	....	1.91	....	....	.40	412.37
February	400.00	27.25	....	6.60	....	1.89	.45	436.19
March	632.42	51.05	71.00	61.80	....	18.00	2.70	836.97
April	300.00	4.30	....	30.79	6.16	2,853.87	3.25	3,198.37
May	901.68	543.62	228.71	731.57	99.61	2,500.08	52.20	5,057.47
June	1,978.04	395.53	164.08	85.81	....	160.69	540.80	3,324.45
Total	14,804.67	3,263.58	1,885.31	1,464.18	129.52	8,057.37	709.75	30,814.38
For removal of wrecks at Browns Island, near Deadmans Island, and opposite Cincinnati, Ohio	....	....	....	327.04	....	....	....	327.04
Aggregate	....	....	....	....	....	....	....	30,641.42

[Extract from report of Capt. W. H. Christian.]

The snagboat *E. A. Woodruff* left winter quarters in the mouth of the Kentucky River on March 8, 1896, and with two dredge boats, one drill boat, one launch, five dump scows, and one large and three small flatboats in tow, proceeded up the Ohio River, running only in daylight, landing at Cincinnati on March 11.

On arrival, the *Woodruff* was laid up and the crew was suspended without pay pending the preparation of plans, estimates, and proposals for betterments and for the annual spring repairs to the snag boat and her machinery.

The work on betterments and repairs was commenced April 13 and completed May 24, 1896. The betterments were the installment of a new engine and dynamo (direct connected set and wiring), electric lighting plant, and pressure water filter. Repairs were made to the broken wrecking frame legs, main engines, main and auxiliary boilers and their furnaces, steering, donkey, and laundry pumps, one machine-shop and four capstan engines, steam steering apparatus, chimneys and stumps of the large boilers, paddle wheels, and floors of two deck-hand rooms; replaced, with new, two decayed large iron pipe water-wheel beam and bridge tree supporting braces; scrubbed the boat all over; painted, where necessary for preservation, places inside and outside of the hull and upper works, and made numerous small repairs to the hull, upper works, machinery, and snag and wrecking apparatus.

On completion of the annual repairs, the snag boat was commissioned to engage in her regular work of removing obstructions from the Ohio River, and, after taking aboard coal and stores, she cast off May 27 and steamed upstream, running night and day, as far as Pittsburg, Pa., landing there May 31. While en route to Pittsburg she removed from the channel two dangerous snags and two coal-boat and two coal-barge wrecks.

May 31, two hours after arrival at Pittsburg, due to a rapidly falling river and to avoid the risk of grounding and consequent loss of service, the snag boat cast off and proceeded downstream, immediately engaging in and continuing the removal of obstructions until she reached Cincinnati on June 11, where she was tied up to await an assignment of funds to continue her work. Advantage was taken of this time to make shop repairs to the wrecking-hook frame, which was broken while removing a sunken coal barge at a point 53 miles below Pittsburg, and to build a new rudder to replace one worn out, which had been on the boat since 1875.

From June 15 to July 14 the crew of the snag boat, excepting two watchmen, clerk, and master, was suspended without pay. On the latter date funds again became available for the resumption of work, the crew was reemployed, and the repaired wrecking-hook frame and new rudder were taken aboard and erected in their places.

July 15 the boat cast off and steamed upstream, running night and day, arriving at Pittsburg, Pa., July 19; repaired the paddle wheels; took aboard coal, and, on account of falling river, ran down to Stoops Ferry, 12 miles below Pittsburg, and tied up for the night.

July 20, began the removal of some coal-barge wrecks in the vicinity. After their destruction the regular work of removing obstructions was continued to the vicinity of Fish Creek Island, 113 miles below Pittsburg, arriving on the evening of July 23

On account of general heavy rains the river during the night had swollen to a height that prevented work. The snag boat was, therefore, on July 24, steamed upstream to Bellaire, Ohio, 94 miles below Pittsburg, and tied up until August 6, when the river had again fallen to a working stage.

While lying at Bellaire the crew was employed at various kinds of necessary work on the boat, so that the time was not wholly lost to the service.

August 6, cast off and ran up to Wheeling, W. Va., 90 miles below Pittsburg, took aboard stores, and then steamed downstream, removing obstructions until Cairo, Ill., 967 miles below Pittsburg, was reached, on September 2.

September 3, cast off and worked upstream until a sunken boat loaded with very large limestones, at a point 896¼ miles below Pittsburg, was reached, September 5. This boat was sunk many years ago, became covered with sand, and was therefore no obstruction to navigation until this season, when the wreck, due to changed conditions, divided the channel in such a manner as to make it extremely dangerous in low-water stages to all passing craft. From this wreck the snag boat removed 80 stones, measuring about 493 cubic feet, and all of the wreck that could be obtained with the facilities at hand from under the sand, leaving a present channel depth of water over the remains.

September 9, cast off and worked upstream until Craigs Bar, 537 miles below Pittsburg, was reached, September 23. Here the snag boat was employed, September 23–26, removing 75 snags and other obstructions from the new channel being made there. Arrived at Cincinnati September 30, made some repairs to the paddle wheels, which had been damaged in the Louisville and Portland Canal by unavoidable collision with displaced fragments of the old walls, and examined the wrecks of three burned steamboats in front of Sedamsville.

October 5, cast off and ran upstream night and day until Short Creek, 81 miles below Pittsburg, was reached, October 9; tied up here until daylight on account of fog. When it lifted the snag boat cast off, and, learning from the Pittsburg packet that no obstructions were reported above, and as the river was falling, she was headed downstream and worked until South Point, Ohio, 314 miles below Pittsburg, was reached, after dark October 15. October 16, the starboard rudder collided with a hidden obstruction, injuring it so badly as to require removal from its working position, obliging the boat to work as far as Cincinnati with only one rudder, arriving October 17. October 19, sent the broken rudder to be repaired, part of the crew building a temporary dock for readjusting it, the remainder making necessary repairs to machinery and guards. These repairs were completed October 27, when the boat proceeded downstream, working as far as Evansville, Ind., arriving there November 10. No obstructions being reported below Evansville, stores were taken aboard, and on November 11 steamed upstream, working as far as New Cumberland, 56¼ miles below Pittsburg, where, after removing a coal-barge wreck and being informed that there were no obstructions above, the boat was headed downstream and hastened to Williamson Island to remove a wreck which menaced the Pittsburg coal fleets then underway. After the removal of this wreck, November 30, the boat continued downstream, performing her regular work as far as Kentucky River, where she went into winter quarters on December 7.

On December 10, after the boat and operating apparatus had been put in order for proper care during suspension of work through the winter, the crew was paid off, and with the exception of two watchmen and the master, who remained to care for the property, all left the boat for their homes.

The *Woodruff* was in commission 172 days between May 25 and December 10. During that time she was tied up 12 days on account of high water, and 28 days awaiting the availability of funds. She traveled 5,553 miles, removed 653 snags, 51 wrecks, 2,276 cubic feet of rock, and cut down 166 trees. Removed 1 rock pile at Half-Moon farm, drift from the railroad piers at Bellaire, Ohio, and Parkersburg, W. Va., and from the ice piers at Pomeroy, Ohio, and spent 3 hours assisting the steamer *W. F. Nisbet* over Craigs Bar.

Time.

	Days.
Running exclusively	79
Removing snags and cutting down trees	21
Removing wrecks	8
Removing rocks	2
Repairing and painting (while tied up for high water)	12
Tied up waiting for funds	28
Sundays worked	2
Sundays not worked	19
Holidays not worked	2
At Cincinnati, making repairs, etc	22
Dragging wrecks, etc	2
Putting boat in order for winter	3

Wrecks removed, wholly or partially, classified, are as follows:

Kind.	Name.	Place.	Number.
Steamboat	Richmond	Grand Chain	1
Do	Robert Moore	Cumberland Island	1
Do	State of Missouri	Alton, Ind	1
Do	Scotia	Cincinnati	1
Canal boats	No name	Scattering	11
Coal barges	do	do	32
Fuel flats	do	do	3
Lumber barge	do	Evansville	1
Total			51

Rocks removed.

Place.	Date.	Cubic feet.
Channel, Sisters Island	September 5 and 8	494
Dean & Stockenberg's landing	November 6	1,782
Total		2,276

Of the snags removed, those weighing 50 tons and over, each, and their locations at the time of removal, are given to show that the largest snags found are not peculiar to any particular locality.

Place.	Miles below Pittsburg.	Tons.
Channel front of Kenova, W. Va	312	62.866
Channel front of Catlettsburg, Ky	314	61.500
Channel front of Twin Creeks, Ohio	370½	84.266
Channel at Hughes Bar, Ind	608	282.720
Channel above Alton, Ind	672½	62.866
Channel below Grissoms Landing, Ky	758	55.978
Channel front of Elm-tree Landing, Ky	760	115.220
Channel front of Barnetts Landing, Ky	798	100.712
Channel front of Watsons Landing, Ky	820½	52.833
Do	820½	55.666
Channel front of Strips Landing, Ind	825	133.200
Mouth Saline River Illinois	850½	77.510
Caseyville Landing, Ky	860½	113.160
Channel front of Bennetts Landing, Ky	875½	189.050
Channel front of Fox Clanahans, Ill	897	82.458
Channel, Stewarts Island	902	53.760

Total weight of snags destroyed, 5,170 tons.

Supplemental to my report for the calendar year 1896 is the following statement of snag-boat work in 1897 up to the close of the fiscal year:

The snag boat *Woodruff* remained in winter quarters in the mouth of Kentucky River until March 7, 1897, when she left for Cincinnati, towing two dredge boats, one drill boat, one steam launch, five dump scows, and three flatboats. On account of high water and strong current, particularly between the piers of the bridges, the snag boat was obliged to divide this tow into three parts, 9 miles below Cincinnati, and make three trips from that point. The dredge boats, dump scows, and flatboats were landed at Newport, Ky., the drill boat and launch at the Queen City Landing, and the snag boat at the foot of Niagara street, Cincinnati, March 12, 1897.

Began work on the annual spring repairs and betterments of the snag boat *Woodruff* April 7 and concluded them on May 20, 1897. The betterments consist of an electric storage-battery plant for convenient lighting, low-pressure steam heating system in place of stoves, one new auxiliary pump, duplex instead of single acting;

iron circles for paddle wheels, and large grooved drums and steel hook for wrecking machinery.

The parts repaired were four water-wheel beams, two wheel chain braces, two paddle wheels, furnace and steampipe attachments of the large boilers, two main engine exhaust pipes, doctor, capstan engines and capstan machinery, woodwork of wheel and side houses, clerk's office and cabin rooms, and the iron main deck where rusted through; also the snag and wrecking tackle blocks and rigging. Made alterations to the steam valves and valve connections of the main engines, which has considerably reduced the consumption of fuel.

After taking aboard coal and stores the snag boat left Cincinnati May 22, bound upstream, running night and day until Beaver Dam, 30 miles below Pittsburg, was reached, May 25. No important work being reported and the water being scant and falling above this point, the snag boat was headed downstream May 26, and continued her regular work of removing snags and wrecks until she arrived at Cincinnati, 466 miles below Pittsburg, on June 7, where she was detained until June 16, making repairs to her wrecking machinery and the bottom of the boat, which had been unavoidably broken in the trip's work between Beaver Dam and Cincinnati. On completion of repairs the boat left Cincinnati, engaging in the removal of obstructions until Evansville, Ind., 783 miles below Pittsburg, was reached, June 25. There being, due to high water, no known obstructions between Evansville and Cairo, the snag boat was ordered to return to Cincinnati. Left Evansville June 26, running in daylight to insure the removal of obstructions unknown and unobserved on the down trip, or new ones that had made their appearance since. June 30, 1897, the snag boat arrived at Madison, Ind., 553 miles below Pittsburg.

Between May 21 and June 30, 1897, the snag boat traveled 1,484¼ miles; removed 152 snags, 70 cubic yards of rock, and the following wrecks: 1 coal boat, 7 coal barges, 1 fuel flat, 1 sand boat, and 1 brick boat.

C C 3.

OPERATING AND CARE OF DAVIS ISLAND DAM, OHIO RIVER, NEAR PITTSBURG, PENNSYLVANIA.

The principal work of the year was the replacing of the old and worn-out wooden gates by new steel ones, with new tracks, all the work, except the laying of the tracks, being done under contract with John P. McGuire, of Cleveland, Ohio, approved July 27, 1896. The general design of the gates is the same as formerly, but the experience gained with the old ones has been utilized, especially in hanging so as to avoid friction in the gate seats, and in the arrangement of valves giving a largely increased capacity for filling and discharging the lock.

The Chanoine movable dam has been in good condition, requiring no repairs, and causing no delay to navigation.

The upper guiding crib is gradually wearing away, but the only work justifiable would be entire renewal.

Some minor repairs were made, sediment left by floods was cleared away, and some improvements were made to the grounds about the lock.

There was no interruption to navigation during the year.

The dam was raised five times and lowered four times, and was up eighty-six days.

The commercial statistics for this work are included in those relating to the Ohio River proper.

The work has been under the efficient supervision of Mr. William Martin, assistant engineer, an extract from whose report is appended.

Detailed statement of expenses incurred at the Davis Island Dam, Ohio River, during the fiscal year ending June 30, 1897.

Month.	Operating expenses.				Maintenance and repairs.					Aggregate.
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Labor.	Material.	Plant.		Total.	
							Purchase and repair.	Hire.		
1896.										
July	$764.28	$114.90	$48.78	$927.91	....	$2.88	....	......	$2.88	$930.79
August	680.27	60.37	78.75	819.39	$24.00	16.13	$25.45	......	65.58	884.97
September	849.00	259.91	26.80	1,135.71	16.67	81.71	2,045.59	......	2,143.97	3,279.68
October	663.33	17.77	117.89	798.90	....	62.50	815.46	......	877.96	1,676.95
November	830.00	49.15	238.24	1,117.39	....	3.90	....	......	3.90	1,121.29
December	500.00	26.60	53.77	580.37	484.12	251.76	8,900.00	$31.00	9,666.88	10,247.25
1897.										
January	825.00	114.27	25.22	964.49	....	206.00	1,017.78	75.00	1,298.78	2,263.27
February	500.00	51.67	24.42	576.09	574.18	75.23	10.09	48.00	707.50	1,283.59
March	700.00	37.00	24.41	761.41	150.00	....	....	......	150.00	911.41
April	504.46	43.90	24.42	572.78	....	....	1,124.24	......	1,124.24	1,697.02
May	700.00	193.54	25.03	918.57	....	....	874.67	......	874.67	1,793.24
June	518.83	80.86	51.81	651.00	352.11	20.50	8,901.80	......	9,274.41	9,925.41
Total	8,035.17	1,049.44	739.49	9,824.10	1,601.08	720.61	23,715.08	154.00	26,190.77	36,014.87

Operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa.

The following is a statement of the amounts and dates of all allotments for this work.

August 3, 1885	$5,865.00
July 10, 1886	12,015.00
January 28, 1887	6,700.00
July 1, 1887	12,355.00
February 25, 1888	3,500.00
July 11, 1888	18,015.00
August 20, 1889	12,073.00
May 14, 1890	2,000.00
July 17, 1890	14,752.00
October 7, 1890	14,800.00
July 10, 1891	10,338.00
July 21, 1892	$11,831.48
June 27, 1893	1,300.00
July 22, 1893	12,253.82
July 18, 1894	12,459.02
May 25, 1895	450.00
July 9, 1895	30,661.54
July 28, 1896	15,531.57
May 17, 1897	1,200.00
Total	198,100.43

Abstract of proposals for furnishing gate track rails and steel lock gates for lock at Davis Island Dam, Ohio River, received in response to advertisement dated June 11, 1896, and opened at Cincinnati, Ohio, July 11, 1896, by Maj. W. H. Heuer, Corps of Engineers.

No.	Name of bidder.	Gate track rails, 42 tons.		Two steel lock gates.		Total amount of bid.
		Price per ton.	Amount.	Price each.	Amount.	
1	Fort Pitt Bridge Works of Pittsburg	$41.50	$1,743.00	$10,650.00	$21,300,00	$23,043.00
2	Wisconsin Bridge and Iron Co	43.40	1,822.80	10,442.30	20,884.60	22,707.40
3	Ritter & Conley	45.00	1,890.00	10,562.00	21,124.00	23,014.00
4	The Cincinnati Architectural Iron Works Co	48.60	2,041.20	12,690.00	25,380.00	27,421.20
5	Francis C. McMath	60.00	2,520.00	11,000.00	22,000.00	24,520.00
6	Thomas Carlin's Sons	54.20	2,276.40	14,947.00	29.394.00	32,170.40
7	Gustave Kaufman	64.50	2,709.00	11,000.00	22,000.00	24,709.00
8	John P. McGuire[a]	45.00	1,890.00	8,900.00	17,800.00	19,690.00
9	Maryland Steel Company	65.00	2,730.00	14,500.00	29,000.00	31,730.00
10	R. H. Hood	64.75	2,719.50	11,890.00	23,780.00	26,499.50

[a] Recommended for acceptance.

Contract in force during the fiscal year ending June 30, 1897.

Contractor.	Work of improvement.	Date of contract.	To expire.
John P. McGuire......	Gate-track rails and lock gates,	July 23, 1896	Gate-track rails, September 15, 1896; lock gates, December 1, 1896; completed when gates are in place on track and accepted and all staging, false work, etc., removed.

Date of approval, July 27, 1896. To commence as soon as possible after receipt of notification of approval.

[Extract from report of Mr. William Martin.]

New lock gates.—The wooden lock gates which have been in service since the dam was inaugurated, a period of twelve years, have been replaced by steel gates. The gates are of the caisson type. The principal stiffening member in the old gates was a Howe truss, arranged to lie above the normal level of the pool. The substructure of the gate rested on thirty wheels and axles having a plain tread, traveling on a flat-rail track 11 feet 6 inches gauge, at right angles to the axis of the lock; the flanges for guiding the wheels were vertical posts extending 13 inches below the track, on the bottom of which were friction rollers. These posts were the principal members composing the water screen on the lower side of the gate. Similar posts on the upper side served as a flange for the wheels on that side. A lateral movement of 2 inches was provided between the flanges, to allow the gate to be relieved of the friction between the seats; this movement required the gate to slide on the wheels parallel to the axis of the lock. This sliding action caused such a strain on the wheels and axles as to break the flanges of all the original wheels and one-half of the axles. These breakages caused inconvenience and many delays to navigators while awaiting repairs. The lower lock gate had fourteen circular butterfly valves, 38 inches in diameter, for discharging the lock, with seven similar valves in the gate recess 4½ feet in diameter. In the upper gate the valves were omitted, as the lock was filled through fourteen valves 4½ feet in diameter, located in the lock walls. In the new gates a Pratt truss is used, arranged in general design the same as the old one; flanged wheels are used, and the lateral movement of 2 inches to avoid friction of the seats is provided for by suspending the gate from each axle bearing by a pendulum, on which the gate hangs. When the pressure of water is on the gate it swings 2 inches up to its seat, and when in quiescence the pendulums assume the perpendicular; the gate seat in this position stands 2 inches away from the track. These gates have fourteen rectangular valves, 3 by 6 feet, hung vertically and hinged at the top, operated by suitable mechanism. They give a largely increased capacity, both for filling and discharging the lock. These gates were put in operation on the 11th of June, and so far as can be judged in so short a time they work very satisfactorily. The new gates were built by Mr. John P. McGuire, of Cleveland, Ohio, under contract dated July 23, 1896. They were erected on the gate-recess walls, and lowered to their tracks, a distance of 19 feet, by the erection of false work. Fourteen long screws, 26 feet long, 1¾ inches diameter, were used, each being operated by two men on long wrenches. With the gate suspended on the screws it was landed on the tracks without any change of rigging, all the screws being moved simultaneously. It required one and one-half days to lower each gate to the tracks.

Lock-gate tracks.—The tracks of the old lock gates, as well as the gates, were in very bad condition, requiring renewal. The change in design of the substructure of the new gate required a different design for the tracks, adapted to the changed form of wheel. The new tracks were included in the contract of Mr. John P. McGuire, the contractor for the lock gates. The terms of the contract required the tracks to be delivered at the site of the dam. They were placed in position by the United States. The putting in place of the new tracks began December 16, 1896, but by the frequent interruptions by high water and cold weather we did not complete the work until the 2d of June, having but forty useful working days.

Movable dam.—The Chanoine dam has been in good condition during the year; no repairs were necessary, and there were no delays to navigation from any cause in connection therewith.

Upper guiding crib.—The gradual wearing away of this crib is going on, caused by the decay of the exposed timber. No attempt has been made to repair this work, as nothing short of an entire renewal would justify any expenditure.

River-gauge reports.—The river-gauge reports continue to be received in the morning from the United States Weather Bureau from all the principal tributaries above the dam and in the evening from special observers under our direction, who, in case of sudden rises, send warnings every hour.

Natural gas.—Our supply of natural gas for fuel and light is still received from the Bellevue and Glenfield Natural Gas Company, at the same rate as paid for several years.

Maneuvers of the dam.—The dam was down at the beginning of the fiscal year, was raised July 2, lowered July 16, 1896; raised August 18, lowered September 30; raised October 9, lowered October 15; raised October 31, lowered November 6, 1896; raised June 12, 1897.

Duration in days of the various stages of water in the Ohio River at the Davis Island Dam for nine years ending December 31, 1896.

Month.	1888.			1889.			1890.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	1	30	19	....	31	30	....	31	31
February	....	29	26	....	28	13	....	28	28
March	....	31	29	....	31	29	....	31	31
April	....	30	25	....	30	25	....	30	26
May	....	31	18	....	31	21	....	31	31
June	1	29	2	....	30	30	....	30	30
July	3	28	8	....	31	13	14	17	1
August	13	18	6	5	26	2	13	18	9
September	1	29	6	18	12	....	....	30	21
October	1	30	23	6	25	3	....	31	31
November	....	30	26	....	30	30	....	30	29
December	....	31	18	....	31	31	....	31	17
Year	20	346	201	29	336	227	27	338	285

Month.	1891.			1892.			1893.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	....	31	31	....	31	22	....	31	6
February	....	28	28	....	29	27	....	28	28
March	....	31	31	....	31	29	....	31	31
April	....	30	26	....	30	30	....	30	30
May	1	30	....	....	31	29	....	31	31
June	....	30	21	....	30	22	1	29	3
July	....	31	13	....	31	5	10	21	....
August	....	31	12	14	17	....	29	2	....
September	9	21	4	21	9	....	25	5	....
October	20	11	....	31	....	....	15	16	2
November	9	21	7	1	29	2	2	28	4
December	....	31	29	....	31	12	....	31	31
Year	39	326	202	67	299	178	82	283	166

Month.	1894.			1895.			1896.		
	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.	Under 3 feet.	3 feet and over.	6 feet and over.
January	....	31	31	....	31	23	....	31	12
February	....	28	28	....	28	....	....	29	29
March	....	31	31	....	31	31	....	31	29
April	....	30	30	....	30	24	....	30	30
May	....	31	20	....	31	....	....	31	8
June	....	30	12	23	7	....	....	30	6
July	27	3	....	7	24	....	....	31	14
August	31	....	....	23	8	....	4	27	9
September	12	18	7	25	5	....	21	9	....
October	24	7	....	31	....	....	....	31	21
November	....	30	2	19	11	5	....	30	21
December	....	31	17	4	27	12	....	31	17
Year	94	270	178	132	233	95	25	341	196

C C 4.

MOVABLE DAMS IN OHIO RIVER.

At Lock and Dam No. 6, 30 miles below Pittsburg, operations for the completion of the lock were carried on by day labor until early in December, when suspended. Except as stated below, all work required to complete the lock was finished at that time.

The work done was as follows: Stone masonry was built in each lock wall for a length of 100 feet to close gaps left under a former plan, since altered; this completes the masonry work except a small amount at each gate for operating machinery. The brick conduit, for conveying pipes from the power house to river wall of lock, was finished; the protection crib for the lock-filling valves was completed by building 50 feet; the corresponding crib for the discharging valves lacks 45 feet to complete; 52 feet of the drift chute behind the land wall was built, completing that work; 45 feet of the lower flushing conduit was constructed, completing both conduits; the concrete of the guiding walls above and below the lock was finished to the full height, and the timber facing on the upper wall built nearly up to water level; the completion of this work and all the facing for the lower wall was prevented by high water. A large amount of dredging was done in the lock and its approaches.

A project for the navigable pass was approved June 10, 1896, and in July, 1896, bids were invited for the construction of a Chanoine movable dam, 600 feet long, and a stone masonry pier, 93 feet long, to which the dam would be connected. All proposals received were rejected as being excessive in price. Proposals were again opened on March 1, 1897, and the work awarded to Hulings Bros., of Pittsburg, Pa., under contract approved April 29, 1897. Work under this contract was begun June 2, 1897.

The work done during the year, both by day labor and contract, is stated below in report of Mr. William Martin.

The commercial statistics for this work are included in the report on the Ohio River.

Under date of June 22, 1897, a project was submitted for closing the gap of 400 feet, including piers, between the navigable pass and the abutment on the left shore, by means of three bear-trap dams, each 121 feet in length; an estimate was also included for the gates, machinery, buildings, etc., to complete the work. This project awaits approval.

On Dams Nos. 2, 3, 4, and 5 negotiations have been in progress throughout the year for acquiring the desired land; that for No. 2 has been purchased, a deed for one tract at the site of No. 4 has been submitted to the Attorney-General for his action, and condemnation proceedings have been instituted for a part of the remainder.

At the close of the year projects, plans, and specifications for the construction of Dams Nos. 2, 3, and 4 by contract are being prepared for early submission.

All work connected with the movable dams is under the supervision of Mr. William Martin, assistant engineer, whose experience on the Davis Island Dam and superior fitness for the work has been of the highest value.

The following is a summary of work done both by day labor and under contract.

Work by day labor.

LAND LOCK WALL.

Concrete placed in foundation	cubic yards	40
Concrete backing	do	287
Ashlar masonry	do	313
Rubble masonry	do	22
Coping laid	do	59
Cost of material		$3,784.83
Labor		1,828.92
Total		5,613.75

RIVER LOCK WALL.

Concrete backing	cubic yards	191
Ashlar masonry	do	419
Stone cut for voussoirs and coping	do	96.89
Coping laid	do	147.50
Concrete laid in foundation	do	111
Cost of material		$5,037.24
Labor		5,153.10
Total		10,190.34

CONDUITS FOR PIPES TO HYDRAULIC JACKS.

Concrete placed in foundation across the lock chamber	cubic yards	164
Brick masonry laid	do	119
Linear feet completed	do	187
Cost of material		$1,079.00
Labor		2,923.77
Total		4,002.77

GUIDING WALLS.

Excavation for lower wall	cubic yards	429
Excavation for upper wall	do	231
Concrete placed in lower wall	do	450
Concrete placed in upper wall	do	1,940
Oak timber facing on upper and lower walls	feet B. M.	86,092
Cost of material		$6,164.94
Labor		5,775.00
Total		11,939.94

DREDGING.

Approaches to lock	cubic yards	18,945.4
Excavated from lock chamber	do	4,107
Labor		$5,266.77

FLUSHING CONDUIT AND DRIFT CHUTE.

Excavation for lower flushing conduit and drift chute	cubic yards	428
Concrete placed in foundation and walls	do	157
Brick masonry laid	do	49
Cost of material		$470.00
Labor		749.71
Total		1,219.71

PROTECTION CRIBS IN FRONT OF LOCK VALVES.

White oak and pine timber placed in crib structure ....feet B. M..	6,674

Cost of material	$146.83
Labor	20.69
Total	167.52

WORK UNDER CONTRACT.

The cost of the work done by Hulings Bros., from June 2 to 30, 1897, under contract for Chanoine Dam and pier was $5,131.29.

Money statement.

July 1, 1896, balance unexpended		$204,611.88
Amount appropriated by sundry civil act approved June 4, 1897		700,000.00
		904,611.88
June 30, 1897, amount expended during fiscal year		71,791.51
July 1, 1897, balance unexpended		832,820.37
July 1, 1897, outstanding liabilities	$4,684.45	
July 1, 1897, amount covered by uncompleted contracts	86,980.04	
		91,664.49
July 1, 1897, balance available		741,155.88

Amount (estimated) required for completion of existing project	2,570,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899, continuing construction of Dams 2, 3, 4, and 5	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

The following is a statement of the amount and date of all appropriations for this work:

September 19, 1890, construction of Lock and Dam No. 6	$250,000
July 13, 1892, construction of Lock and Dam No. 6, and purchase of land for No. 2	*100,000
August 17, 1894, construction of Lock and Dam No. 6	75,000
March 2, 1895, construction of Lock and Dam No. 6	150,000
June 3, 1896, construction of Lock and Dam No. 6	25,000
June 3, 1896, construction of Locks and Dams Nos. 2, 3, 4, and 5, and purchase of land for Nos. 3, 4, and 5	†30,000
June 4, 1897, construction of Dams 2, 3, and 4	400,000
June 4, 1897, construction of Dam No. 6	300,000
Total	1,330,000
June 3, 1896, authorizes contracts for construction of Dams Nos. 2, 3, 4, 5, and 6	2,290,000
June 4, 1897, amends above in relation to Dams Nos. 2, 3, 4, and 5, and authorizes contracts for	1,990,000

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*The bill provides that so much of this money as may be necessary may be used in making survey for location of Dam No. 2 and acquiring title to the land. The survey has been made and the land purchased.

†The bill provides that $20,000, or so much thereof as may be necessary, may be used for purchase of sites for Dams Nos. 3, 4, and 5, and, if not sufficient, so much of the moneys heretofore appropriated for Dam No. 6 as shall be requisite may be used for this purpose.

Abstract of proposals for furnishing ironwork for Movable Dam No. 6, Ohio River, received in response to advertisement dated July 13, 1896, and opened at Cincinnati, Ohio, August 20, 1896, by Maj. W. H. Heuer, Corps of Engineers.

[Price per pound.]

No.	Name of bidder.	Wrought iron, 207,329 pounds.	Screw bolts, 53,346 pounds.	Driftbolts, 16,264 pounds.	Cast iron, 231,957 pounds.	Total amount of bid.
1	John P. McGuire	$0.044	$0.022	$0.019	$0.02	$15,244.24
2	Scaife Foundry and Machine Co., Limited	.0699	.0265	.0185	.0188	20,567.64
3	Fort Pitt Bridge Works of Pittsburg *a*	.0332	.02125	.0165	.01475	11,706.65
4	Pittsburg Bridge Co	.0484	.027	.0215	.0208	16,649.45
5	Union Foundry and Machine Co., Incorporated	.0542	.0250	.0145	.0166	16,657.20
6	John A. Nichols	.044	.0275	.0275	.0172	15,026.41
7	The Snead & Co. Iron Works, Incorporated	.0663	.0325	.023	.0216	25,010.58
8	Chas. B. Gracey & Co	.095	.035	.0325	.029	28,818.70
9	Riter & Conley	.059	.0297	.0257	.0227	19,500.29
10	The Novelty Iron Co	.03	.025	.015	.02	12,436.62
11	Thomas Carlin's Sons	.0612	.0248	.0179	.0168	18,199.52
12	The Hoefinghoff and Laue Foundry Co	.06125	.031	.022	.0175	18,769.68

a Recommended for acceptance.

Abstract of proposals for constructing a Chanoine movable dam and stone-masonry pier at Lock No. 6, Ohio River, received in response to advertisement dated July 13, 1896, and opened at Cincinnati, Ohio, August 20, 1896, by Maj. W. H. Heuer, Corps of Engineers.

Articles.	Quantities.	1.—I. V. Hoag.	2.—C. I. McDonald.	3.—Wm. B. Rodgers.	4.—John J. Shipman.	5.—Jutte & Foley Co.	6.—Keeling & Ridge.
Framing timber....linear feet..	1,000	$0.40	$0.35	$0.39	$0.15	$0.30	$0.20
Sheeting.......1,000 feet B. M..	286,100	45.00	40.00	29.50	22.00	26.00	25.00
Coffer tie rods.........pounds..	47,200	.05	.05	.0388	.04	.06	.0325
Earth filling......cubic yards..	10,580	1.00	2.00	.45	1.00	.90	.40
Common excavation.......do....	12,800	1.50	1.00	.45	1.50	1.25	.40
Hardpan excavation .....do....	....	2.00	1.75	.90	2.00	2.00	.75
Rock excavation.........do....	....	2.00	5.00	.90	2.50	3.00	2.00
Temporary piling..linear feet..	3,200	.70	.60	.39	.25	.30	.30
Permanent piling........do....	18,150	.75	.75	.39	.28	.40	.50
Sheet piling ...1,000 feet B. M..	....	45.00	40.00	25.00	22.00	30.00	25.00
Concrete ....cubic yards..	5,948	7.00	7.00	4.99	5.75	5.00	5.00
Ashlar masonry..........do....	280	16.00	10.00	19.90	*a* 10.00	15.00	13.50
Coping ....do....	102	19.00	20.00	22.90	22.00	27.00	20.00
Stone filling ....do....	6,200	2.00	3.00	2.10	3.00	2.75	2.00
Timber in permanent construction..........1,000 feet B. M..	392,000	85.00	75.00	59.00	38.00	45.00	50.00
Bolt holes in masonry, linear feet	....	.90	.50	.25	.10	.20	.25
Electric conduit....linear feet .	....	.50	.80	.50	.50	.40	.25
Total of bid	....	155,041.00	158,122.50	103,245.13	116,735.20	115,696.60	95,833.50

a Oolitic stone at $15.

No bid accepted.

Abstract of proposals for constructing a Chanoine dam and stone-masonry pier at Lock No. 6, Ohio River, received in response to advertisement dated January 28, 1897, and opened at Cincinnati, Ohio, March 1, 1897, by Maj. W. H. Heuer, Corps of Engineers.

Articles.	Quantities.	1.—John J. Shipman.	2.—Christie & Lowe.	3.—Jutte & Foley Co.	4.—Sturm & Cramer.	5.—C. I. McDonald.	6.—Gustave Kaufman.	7.—Israel V. Hoag.	8.—Wm. B. Rodgers.	9.—Hulings Bros.[a]	10.—Sloan, McIlvain & Ott Bros.	11.—Richardson & Young.
Framing timber.......linear feet..	1,000	$0.30	$0.24	$0.30	$0.15	$0.35	$0.30	$0.40	$0.29	$0.156	$0.80	$0.25
Sheeting................feet B. M..	249,880	30.00	40.00	26.00	22.00	35.00	44.00	35.00	29.50	20.50	28.74	30.00
Coffer tie rods............pounds..	67,795	.04	.04	.06	.05	.05	.05	.03	.039	.0254	.03	.04
Earth filling.........cubic yards..	7,417	1.50	.24	.90	.60	.95	.75	.95	.59	.66	.35	.75
Common excavation.........do....	19,831	.80	.50	1.25	.60	.80	.75	1.40	.49	.4318	.35	1.00
Hardpan excavation ....do....	....	3.50	2.00	2.00	1.25	2.50	2.00	1.40	.90	.75	.80	2.00
Rock excavation.............do....	....	4.00	3.50	3.00	2.50	5.00	3.00	1.40	.90	1.50	2.50	3.00
Temporary piling .....linear feet..	4,200	.30	.26	.30	.50	.60	.40	.28	.39	.36	.50	.30
Permanent piling............do....	19,890	.30	.42	.40	.50	.70	.40	.30	.49	.31	.50	.40
Sheet piling ....feet B. M..	....	30.00	40.00	30.00	50.00	35.00	40.00	35.00	24.90	35.00	28.00	30.00
Concrete.............cubic yards..	5,502	4.90	4.00	5.00	4.70	6.50	3.30	7.00	4.99	3.92	4.14	5.00
Ashlar masonry.............do....	287	15.00	12.00	15.00	10.00	12.00	15.00	18.00	14.90	12.65	12.00	18.00
Coping ....do....	105	25.00	17.50	27.00	12.00	18.00	30.00	21.00	19.90	15.75	17.00	18.00
Stone filling ....do....	5,072	2.00	2.05	2.75	2.50	2.75	1.40	2.47	2.49	2.25	2.00	2.10
Timber in permanent construction....................feet B. M..	567,143	30.00	51.00	45.00	45.00	50.00	50.00	70.00	54.00	40.00	40.40	50.00
Bolt holes in masonry..linear feet..	....	.25	.36	.20	.50	.75	.50	.35	.25	.50	.20	.20
Brick conduit.........cubic yards..	44	20.00	9.00	15.00	8.00	9.00	11.00	15.00	14.00	12.00	12.00	14.00
Cast-iron washers.........pounds..	11,660	.03	.03	.03	.04	.03	.05	.05	.029	.017	.025	.03
Air conduit, 4 inches diameter, linear feet	624	.90	.30	.50	.50	.45	1.40	.75	.79	.528	.50	.30
Electric conduit, 3 inches diameter, linear feet	600	.80	.25	.40	.40	.35	1.20	.50	.69	.408	.40	.20
Total amount of bid	....	108,044.99	101,782.77	127,225.86	106,992.14	136,478.25	108,486.62	153,256.05	114,719.66	90,613.89	93,805.70	118,480.30

[a] Recommended for acceptance.

List of contracts in force during the fiscal year ending June 30, 1897.

Iron work for Dam No. 6: Fort Pitt Bridge Works of Pittsburg, Pa.; September 2, 1896; approved October 6, 1896; commence as soon as possible after notification of approval of contract; complete delivery under first payment by November 1, 1896; all other parts by December 1, 1896. The deliveries have been completed and payment made to contractors.

Construction of Chanoine Movable Dam No. 6 and stone masonry pier: Hulings Bros.; March 19, 1897; approved April 29, 1897; commence work by ordering material within twenty days after receipt of notification of approval of contract; complete December 1, 1897. Work now in progress.

[Extract from report of Mr. William Martin.]

This work has heretofore been performed by the day-labor system. Under the present project the stone masonry of the lock is practically completed; the following work has yet to be built and put in: The lock gates and operating machinery, poiree dams for unwatering the gate recesses in case of repairs, and finishing the timber facing of the guiding walls. The lock gates and operating machinery need not be built until the completion of the dam. The river and harbor act of June 3, 1896, directs that the remainder of the project be contracted for. In accordance therewith a contract for the construction of the navigable pass, having a width of 600 feet, has been entered into with Messrs. Hulings Bros., of Pittsburg, Pa., dated March 19, 1897. The contractors began work on the 2d of June. At the close of the last fiscal year the following work remained to be done to complete the lock so far as practicable to prepare it for the lock gates and operating machinery: Completing the gaps in the masonry of the river and land lock walls, the brick conduit extending from the power house to the river lock wall, the protection cribs in front of the lock filling and discharging valves, the drift chute and flushing conduit at the lower end of the lock, and the guiding walls above and below the lock.

Masonry of lock walls.—A gap about 100 feet long was left in the masonry at the center of the lock walls, designed to conform to a former project now abandoned. This masonry was completed, which included all the masonry of the lock, except a small quantity at each lock gate at the proposed location of the operating machinery, which can not be done until the machinery is ready to place in position.

Brick conduit.—The brick conduit designed to convey the pipes from the accumulator in the power house to the hydraulic jacks in the river lock wall was partially built last year; during the year it was completed. It is 5 feet circular diameter, having a total length of 228 feet.

Protection cribs.—At the end of last year the protection crib in the lock in front of the lock-filling valves lacked 50 feet of completion; this has been finished during the year. The crib outside the river lock wall in front of the lock-discharging valves lacks 45 feet to complete. The portion of this crib built was done at the lowest stage of water by throwing up an embankment to serve as a cofferdam; the river became too high before it could be finished, and it was also postponed for the reason that a portion of it comes beneath the existing cofferdam. This crib will lie entirely within the inclosure of the navigable pass cofferdam, and can be finished when this coffer is built.

Drift chute.—This chute is designed to carry driftwood and other débris from the gate recesses to a point 110 feet below the lower lock gate, discharging into the lower pool through the lower guiding wall. This chute has a trunk section 6 feet wide and 6 feet high, and has a total length of 789 feet; 52 feet was built during the year.

Flushing conduits.—There are two flushing conduits, one at the rear of each lock-gate recess. The upper one discharges into the lock through the land-lock wall at a point 92 feet below the lock gate; the lower one discharges into the lower pool through the lower guiding wall 92 feet below the lock gate. These conduits are designed to flush out the gate recesses of any débris that may accumulate which would interfere with the free movement of the lock gates. Both of these conduits are finished; 45 feet of the lower one was finished during the year.

Guiding walls.—The guiding walls above and below the lock are built of concrete and faced with white-oak timber, so arranged by bolt fastenings that the timber can be removed at any time should it be broken or decayed. The concrete work of these walls was built the full height in the fall and winter of 1896. The timber facing of the upper wall was completed except 5 feet at the water level; we failed to complete this on account of the stage of water. None of the timber work on the low level of the lower wall was done for the same reason. This timber is all on hand ready for putting on as soon as opportunity offers.

C C 5.

IMPROVEMENT OF MUSKINGUM RIVER, OHIO.

The following is a statement of the amount and date of all appropriations for this work:

Act of August 11, 1888	$102,000

At the beginning of the year the only unfinished work on this improvement was the completion of the ice harbor at mouth of Muskingum, for which the river and harbor act of August 17, 1894, had provided the necessary funds from the balance remaining to the credit of this appropriation. (See Annual Report, 1896, part 4, pp. 2103–2105.) The completion of the ice harbor comprised new middle gates for the lock, the building of a dwelling for the lock keeper, and the renovation of the grounds about the lock.

The gates were put in place and are in successful operation, but the construction of the lock-keeper's dwelling is necessarily postponed awaiting the acquisition by the United States of the required land at Marietta, which is still pending.

Commercial statistics relating to the Muskingum are appended to the report on operating and care of the locks and dams.

The work is under the supervision of Mr. Edmund Moeser, assistant engineer, who has performed his duties in a thoroughly commendable manner.

Money statement.

July 1, 1896, balance unexpended	$7,752.01
June 30, 1897, amount expended during fiscal year	2,131.58
July 1, 1897, balance unexpended	5,620.43
July 1, 1897, outstanding liabilities	2.25
July 1, 1897, balance available	5,618.18

[Extract from report of Mr. Edmund Moeser.]

The work carried on for improving Muskingum River, Ohio, was for completion of the ice harbor lock at mouth of Muskingum, under a provision of the river and harbor act of August 17, 1894, which diverted to the ice harbor work a part of the unexpended balance of the appropriation for improving Muskingum River.

At the close of the last fiscal year the project for the completion of this work had been accomplished, except that part relating to construction of middle gates and their equipment; erection of a house for the lock master; and placing in presentable condition the grounds adjacent to the lock.

The new middle gates were finished and placed in position October 21, 1896, since which date they have been successfully operated. These gates are designed for use when one-half of the lock is sufficient for passing craft; since their completion lockings of the ordinary commerce at this place have been much more rapid.

After the gates were hung in positiom, mud valves were placed in both middle-gate recesses, for use in flushing out the sedimentary deposit; the machines for operating the gates were put in place; and concrete additions were built to coping of both walls, to obtain the additional area required for operating the machines.

The United States having as yet not been able to acquire title to the ground upon which it is proposed to build the lock-master's house, this matter, as well as the improvement of the grounds at lock, has been again postponed.

The following expenditures were incurred during the year:

Metal work for middle gates	$1,229.34
Hand rails, bolts, nails, and lumber	44.33
Freight and traveling expenses	24.70
Services	703.71
Total	2,002.08

C C 6.

OPERATING AND CARE OF LOCKS AND DAMS ON MUSKINGUM RIVER, OHIO.

A statement of the extent, original cost, etc., of the works embraced under this title is given in the summary.

The only interruptions to the operation of the 10 locks throughout the year were those caused by ice closing the river for fourteen days in January and February, 1897, and by the accident to the floor in the chamber of Lock No. 1 at Marietta, by which communication between the Ohio and Muskingum was suspended for twenty-nine days in September and October of 1896. This delay was unimportant, as the lock was practically inaccessible at that time on account of low water in the Ohio. Incidental repairs were made as required, and, with a few exceptions, all the work proposed was finished.

The principal operations during the year were as follows:

Lock and Dam No. 1.—Repaired floor of lock chamber; made minor repairs to gate machinery; repaired and repainted lock-master's dwelling.

Lock and Dam No. 2.—Repointed 1,163 square feet of lock masonry; made minor repairs to gate machinery; repainted lock-master's dwelling, storehouse, and lock gates.

Lock and Dam No. 3.—Rebuilt protection crib; repaired breach in embankment behind right abutment; repainted storehouse.

Lock and Dam No. 4.—Repaired head gates and conduit to mill race, and right abutment of dam; refilled embankment behind right abutment; lock gates and storehouse repainted.

Lock and Dam No. 5.—Rebuilt the rear of the lock-master's house, completing the structure.

Lock and Dam No. 6.—Substructure of guide crib below land wall of lock rebuilt for a length of 195 feet.

Lock and Dam No. 7.—Excessive leakage and threatened break through embankment behind right abutment was remedied by the free use of concrete and rubble stone; an extensive fill of sand and gravel was made at upper end of abutment; an earth embankment 70 feet long, paved with stone, was built to prevent overflow of canal.

Lock and Dam No. 8.—Threatened collapse of crib extension below right abutment, by undermining, was averted by an extensive fill of large stone; lock walls repaired; lock-master's dwelling repainted.

Lock and Dam No. 9.—Rebuilt top of dam next to lock for a length of 162 feet; minor repairs to machinery; repainted lock office.

Lock and Dam No. 10.—Repointed 8,421 square feet of lock walls and renewed 364 feet of coping; placed new machines for operating upper gates; repaired apron and second step of dam; repainted storehouse and lock gates.

Besides the work mentioned above, frequent freshets during the year necessitated much cleaning of sediment from the lock walls and machinery.

As far as the conditions will justify, all repairs are made with a view to permanence and stability, but as most of the structures were in bad condition when received from the State some work of renovation is constantly demanded.

Good service has been rendered by the U. S. dredge *Malta* and U. S. towboat *Vega;* machinery of both boats was repaired; the hull of the floating pile driver will be rebuilt.

Under authority of the Secretary of War the old wooden draw in the bridge of the Cincinnati and Muskingum Valley Railway Company has been replaced by an iron structure.

The work on the Muskingum River is under the excellent supervision of Mr. Edmund Moeser, assistant engineer.

Detailed statement of expenses incurred on Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1897.

GENERAL ADMINISTRATION.

Month.	Salaries.		Plant.		Repair of buildings.	Supplies.	Transportation.	Miscellaneous.	Total.
	Office force.	Lock masters, bridge tender, gauge reader, and watchman.	First cost.	Repairs.					
July	$515.00	$645.00	....	$6.11	$6.16	$2.20	$19.19	$36.43	$1,230.09
August	500.00	645.00	$16.45	....	....	5.05	....	52.52	1,219.02
September	475.00	644.59	55.46	118.63	170.76	1.00	1.82	72.45	1,539.71
October	415.00	634.64	6.00	120.91	26.10	9.93	....	32.28	1,244.86
November	570.00	633.20	.56	3.22	....	15.68	....	59.05	1,281.71
December	345.00	634.64	6.00	.90	....	18.07	3.42	37.03	1,045.06
January	545.00	646.09	....	....	....	18.05	....	36.93	1,246.67
February	795.00	645.00	....	....	....	9.35	....	32.58	1,481.93
March	470.00	645.00	....	2.75	42.07	10.25	1.55	34.88	1,206.50
April	345.00	645.00	15.89	4.61	....	10.25	....	37.29	1,058.04
May	470.00	645.00	.50	3.30	....	44.94	....	41.18	1,204.92
June	345.00	645.00	17.42	1.02	51.50	....	....	37.28	1,097.22
Total	5,790.00	7,708.76	118.28	261.45	296.59	144.77	25.98	509.90	14,855.73

U. S. DREDGE MALTA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Towboat.	Total.
July	$487.22	$48.67	$56.15	$1.95	$621.00	$1,214.99
August	502.80	....	20.51	87.07	598.00	1,158.38
September	480.77	9.00	42.57	14.00	598.00	1,144.34
October	457.10	88.55	47.50	23.32	644.00	1,210.47
November	491.00	....	2.30	129.33	575.00	1,197.63
December	436.60	....	61.60	20.36	368.00	886.56
January	136.00	....	....	....	....	136.00
February	100.00	....	....	20.85	....	120.85
March	132.50	....	....	509.40	....	641.90
April	235.67	....	....	39.92	....	275.59
May	432.28	13.00	8.00	26.62	....	479.90
June	496.84	....	80.00	29.63	552.00	1,158.47
Total	4,388.78	109.22	318.63	852.45	3,956.00	9,625.08

U. S. STEAMER VEGA.

Month.	Salaries.	Equipment.	Supplies.	Repairs.	Total.
July	$360.38	$1.56	$25.59	....	$387.53
August	360.50	3.05	29.74	....	393.29
September	342.50	2.83	27.35	$1.50	374.18
October	327.50	....	35.04	....	362.54
November	359.90	....	17.46	....	377.36
December	268.25	....	14.40	....	282.65
January	60.00	....	....	....	60.00
February	60.00	....	....	....	60.00
March	60.00	....	24.24	....	84.24
April	158.35	7.00	4.12	39.37	208.84
May	282.50	....	5.00	3.15	290.65
June	301.90	....	27.00	5.00	333.90
Total	2,941.78	14.44	209.94	49.02	3,215.18

Detailed statement of expense incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 1.

Month.	Labor.	Material.	Supplies.	Hire of plant.	Total.
July	$44.31				$44.31
August	66.78	$16.38			83.16
September	425.48	151.74		$23.00	600.22
October	45.06	44.86		3.00	92.92
November	57.18			22.55	79.73
December	4.80				4.80
February	11.52		$7.50		19.02
March	26.64		2.13		28.77
April			2.62		2.62
May	18.92				18.92
June			5.72		5.72
Total	700.69	212.98	17.97	48.55	980.19

LOCK AND DAM NO. 2.

July	$8.64				$8.64
September	65.16				65.16
October	92.28	$24.35			116.63
February	5.76				5.76
March	17.28				17.28
April	43.20				43.20
May	14.04				14.04
June	8.16				8.16
Total	254.52	24.35			278.87

LOCK AND DAM NO. 3.

July	$80.94	$12.32			$93.26
August	184.48	25.00			209.48
September		95.20			95.20
October			$4.64		4.64
November	62.04	68.53			130.57
May			4.04		4.04
June	5.50		4.24		9.74
Total	332.96	201.05	12.92		546.93

LOCK AND DAM NO. 4.

July	$14.40				$14.40
August	18.90				18.90
October	18.00				18.00
November	64.20	$68.53	$4.64		137.37
February	19.80				19.80
March	10.98				10.98
April	6.12				6.12
May	5.76				5.76
June	80.46	141.53			221.99
Total	238.62	210.06	4.64		453.32

LOCK AND DAM NO. 5.

August	$5.94				$5.94
September	98.69				98.69
October	53.56				53.56
November	47.90				47.90
February	4.32				4.32
Total	210.41				210.41

Detailed statement of expense incurred on Muskingum River, etc.—Continued.

LOCK AND DAM NO. 6.

August	$2.88	$25.00			$27.88
September	167.67	190.40		$2.00	360.07
October	138.24			10.00	148.24
November	114.57	68.53			183.10
Total	423.36	283.93		12.00	719.29

LOCK AND DAM NO. 7.

July	$39.48				$39.48
September			$4.68		4.68
October	20.52	$44.23			64.75
November	6.48				6.48
December	40.86		6.78		47.64
February	74.11				74.11
March	20.88				20.88
April	1.08				1.08
May	38.24				38.24
June	244.44	43.16			287.60
Total	486.09	87.39	11.46		584.94

LOCK AND DAM NO. 8.

July	$7.92				$7.92
August	22.32				22.32
September	13.32	$0.25			13.57
October	37.62	21.50			59.12
November	32.94	50.00			82.94
December	56.52	16.85	$4.32		77.69
February	7.56				7.56
March	23.58				23.58
April	50.16	46.80	11.88		108.84
May	53.98				53.98
June	31.86	529.25			561.11
Total	337.78	664.65	16.20		1,018.63

LOCK AND DAM NO. 9.

July	$1.44				$1.44
August	45.90	$30.25			76.15
September	643.42	433.18		$4.00	1,080.60
October	43.92	2.85		10.00	56.77
November	70.74	57.91			128.65
December	25.02				25.02
March	12.06				12.06
Total	842.50	524.19		14.00	1,380.69

LOCK AND DAM NO. 10.

July		$1.15			$1.15
August	$116.32	288.84	$3.18		408.34
September	555.68	762.87	3.00	$4.00	1,325.55
October	237.42	504.10		10.00	751.52
December	129.52	852.97			982.49
February	4.50				4.50
March	7.92				7.92
April	19.26		4.24		23.50
May	23.76				23.76
June	56.88	314.40			371.28
Total	1,151.26	2,724.33	10.42	14.00	3,900.01

For construction of pivot pier of Baltimore and Ohio Southwestern Railway Bridge at Marietta, Ohio.

Month.	Material.
August	$91.80
January	52.70
Total	144.50

SUMMARY.

General administration	$14,855.73	Lock and Dam No. 7	$584.94
U. S. dredge *Malta*	9,625.08	Lock and Dam No. 8	1,018.63
U. S. steamer *Vega*	3,215.18	Lock and Dam No. 9	1,380.69
Lock and Dam No. 1	980.19	Lock and Dam No 10	3,900.01
Lock and Dam No. 2	278.87	Pier of Baltimore and Ohio Southwestern Railway Bridge at Marietta, Ohio	144.50
Lock and Dam No. 3	546.93		
Lock and Dam No. 4	453.32		
Lock and Dam No. 5	210.41		
Lock and Dam No. 6	719.29		37,913.77

The following is a statement of the amounts and dates of all appropriations and allotments for this work:

August 5, 1886 (appropriated)	$20,000.00	December 9, 1891 (allotted)	$1,200.00
July 21, 1887 (allotted)	190,000.00	January 5, 1892 (allotted)	12,241.54
August 13, 1888 (allotted)	177,623.00	August 3, 1892 (allotted)	42,919.47
July 1, 1889 (allotted)	232,080.00	July 22, 1893 (allotted)	52,745.36
July 19, 1890 (allotted)	195,665.00	July 25, 1894 (allotted)	47,157.66
May 28, 1891 (allotted)	20,000.00	July 12, 1895 (allotted)	29,971.20
July 8, 1891 (allotted)	155,200.00	July 24, 1896 (allotted)	41,337.10
November 9, 1891 (allotted)	39,980.00	Total	1,259,320.33
November 24, 1891 (allotted)	1,200.00		

Special work authorized by act of Congress.

March 21, 1895 (allotted), protection wall at Zanesville	$1,651.00
June 17, 1895 (allotted), pier of railroad bridge at Marietta	10,449.60
June 17, 1895 (allotted), pier of county bridge at Taylorsville	5,834.20
Total	17,934.80

Detailed statement and cost of dredging on the Muskingum River, under the appropriation for operating and care of canals and other works of navigation, for the fiscal year ending June 30, 1897.

Date.	Locality	Material excavated.	Total cost.
July	Marietta, Ohio	1,000 yards gravel, sand, and mud, at 12 cents	$120.00
	do	32 round piles, at $2	64.00
	do	16 sheet piles, at $1	16.00
	Lowell, Ohio	8,360 yards gravel, sand, and mud, at 12 cents	1,003.20
	do	1 tree	11.79
August	Marietta, Ohio	2,440 yards gravel, sand, and mud, at 10 cents	244.00
	do	140 piling, at $2.10	294.00
	do	38 yards stone, at 80 cents	30.40
	do	8 logs, at $1	8.00
	do	1 tree	5.68
	Devols Dam, Ohio	1,920 yards gravel, at 10 cents	192.00
	Lowell, Ohio	4,270 yards gravel, sand, and mud, at 9 cents	384.30
September	Marietta, Ohio	4,635 yards gravel, sand, and mud, at 11 cents	509.85
	do	12 piling, at $2	24.00
	do	36 sheet piling, at $1	36.00
	do	6 yards stone, at 50 cents	3.00
	do	6 logs, at $1	6.00
	do	2 snags, at $3.34½	6.69
	do	5,080 yards gravel, at 11 cents	558.80

Detailed statement and cost of dredging on the Muskingum River, etc.—Continued.

Date.	Locality.	Material excavated.	Total cost.
October	Devols Dam, Ohio	3,130 yards gravel, sand, and mud, at 7 cents	$219.10
	Beverly, Ohio	1,260 yards mud and sand, at 6 cents	75.60
	do	9 logs, at 50 cents	4.50
	do	1 stump	7.77
	Baldwins Ripple, Ohio	7,735 yards gravel, at 10 cents	773.50
	do	2 snags, at $10	20.00
	Stockport, Ohio	800 yards sand, at 5 cents	40.00
	McConnelsville, Ohio	1,400 yards mud, at 5 cents	70.00
November	do	2,718 yards gravel, sand, and mud, at 9 cents	244.62
	do	2 snags, at $7.50	15.00
	Eagleport, Ohio	2,020 yards gravel, sand, and mud, at 10 cents	202.00
	Gaysport, Ohio	7,032 yards gravel, sand, and mud, at 7 cents	492.24
	do	1 tree	3.77
	Taylorsville, Ohio	2,400 yards gravel, sand, and mud, at 10 cents	240.00
December	do	2,800 yards gravel, sand, and mud, at 15 cents	420.00
	do	100 linear feet guiding crib, at 99 cents	99.00
	Zanesville, Ohio	1,640 yards sand and mud, at 10 cents	164.00
	do	1,850½ yards gravel, sand, and mud, at 11 cents	203.56
January		For watchman and repairs	136.00
February		do	120.85
March		do	641.90
April		do	275.59
May		do	323.27
	Lowell, Ohio	5,195 yards gravel, sand, and mud, at 3 cents	155.85
	do	1 log	.78
June	Taylorsville, Ohio	21,950 yards gravel, sand, and mud, at 5 cents	1,097.50
	do	30 snags, at $1.50	45.00
	do	1 pair old lock gates	4.60
	do	1 piece dam	11.37
	Total		9,625.08

Muskingum River leases.

YEAR ENDING APRIL 30, 1897.

Location.	Lessee.	Dated—	Expires—
Dam No. 1, Marietta	Phœnix Mill Co	May 1, 1878	May 1, 1908
Dam No. 2, Devols	Gates & Payne	May 1, 1889	May 1, 1909
Dam No. 3, Lowell	Milton King	May 1, 1890	May 1, 1910
Do	F. Wilking & Co	do	Do.
Do	Rechsteiner Bros	do	Do.
Do	do	Nov. 1, 1892	Nov. 1, 1912
Do	E. W. Sprague	Dec. 2, 1879	Dec. 15, 1909
Do	George Rice	Sept. 1, 1889	Sept. 1, 1909
Dam No. 4, Beverly	Robbins Bros	May 1, 1889	May 1, 1909
Do	Langenberg & Abrams	May 1, 1890	May 1, 1910
Do	Mary L. Baldwin	do	Do.
Do	D. T. Brown	do	Do.
Do	Isaac D. Spooner	do	Do.
Dam No. 6, Stockport	Schob & Pierrot	May 1, 1889	May 1, 1909
Dam No. 7, McConnellsville	E. M. Stanberry	Sept. —, 1839	
Dam No, 9, Duncans Falls	John Miller	Dec. 31, 1836	
Dam No. 9, Taylorsville	Frazier & Son	do	
Do	John P. Krier,	May 1, 1896	May 1, 1901
Do	Lewis H. Krier	Nov. 1, 1896	Nov. 1, 1901
Dam No. 10, Zanesville	John T. Drone	May 1, 1890	May 1, 1910
Do	Edward Johnson	do	Do.
Do	do	May 1, 1889	May 1, 1909
Do	Muskingum Coffin Co	May 1, 1890	May 1, 1910
Do	Gary & McLaughlin	do	Do.
Do	T. L. Moorehead	May 1, 1893	May 1, 1913
Symmes Creek	Jasper K. McCann	May 1, 1894	May 1, 1900

YEAR ENDING MAY 31, 1897.

Dam No. 10, Zanesville	John Blankenbuhler	June 1, 1892	June 1, 1909
Do	Frederick Abel	do	Do.

Leases—Water power, land, and rental.

Lessee.	Subject.	Cubic feet of water per minute.	Annual rental.	Rebate.	Rents collected.
Phoenix Mill Co	Water power	8,000	$350.00	$97.57	$252.43
Gates & Payne	do	9,000	108.00		108.00
Milton King [a]	do	2,600	100.00		
F. Wilking & Co	do	7,280	174.72		174.72
Rechsteiner Bros	do	4,446	106.70		106.70
Do	Land		10.00		10.00
E. W. Sprague	do		5.00		5.00
George Rice [b]	do		6.00		3.24
Robbins Bros. [c]	Water power	1,904	100.00		
Langenberg & Abrams	do	5,600	114.24		114.24
Mary L. Baldwin	do	5,000	100.00		100.00
D. T. Brown [d]	do	6,500	118.30	7.79	110.51
Isaac D. Spooner	do	4,000	100.00		100.00
Schob & Pierrot	do	6,390	230.04		230.04
E. M Stanberry [e]	do	(f)			
John Miller [e]	do	(g)	(h)		
Frasier & Son [e]	do	(g)			
John P. Krier	Land		20.40		20.40
Lewis H. Krier [i]	do		30.10		15.05
John T. Drone	Water power	7,560	453.60		453.60
Edward Johnson	do	6,029	361.74		361.74
Do	do	7,399	443.82		443.82
Muskingum Coffin Co	do	4,619	207.86		207.86
Gary & McLaughlin	do	4,794	186.96		186.96
T. L. Moorehead	Land		25.00		25.00
Jasper K. McCann	do		5.00		5.00
John Blankenbuhler	Water power	2,700	100.00		100.00
Frederick Abel	do	5,200	184.50		184.50
Total					3,318.81

[a] Lease canceled July 2, 1896. Lessee insolvent. No collection.

[b] Lease canceled November 13, 1896.

[c] No collection.

[d] Change of wheel June 1, 1896; 6,033 cubic feet of water consumed per minute. Annual rental, $109.80.

[e] Perpetual free lease of water power.

[f] Enough to propel 10-run of 4-foot 5-inch millstones.

[g] Enough to propel 15-run of 4½-foot millstones.

[h] Mill destroyed by fire August 11, 1896.

[i] Lease issued November 1, 1896.

COMMERCIAL STATISTICS.

Commerce of Muskingum River during the calendar year ending December 31, 1896.

LOCK NO. 1.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	19	5		24	24
February	42	5	7	54	54
March	64	31	41	136	136
April	73	23	41	137	137
May	72	15	82	169	169
June	87	25	26	138	138
July	84	27	11	122	122
August	98	55	20	173	173
September	23	14	5	42	42
October	12	12	4	28	28
November	73	22	3	98	98
December	60	15	2	86	86
Total	716	249	242	1,207	1,207

Commerce of Muskingum River, etc.—Continued.

LOCK NO. 2.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	18	4	....	22	22
February	39	2	1	42	42
March	60	9	1	70	70
April	65	5	4	74	74
May	65	7	2	74	74
June	75	14	1	90	90
July	64	16	2	82	82
August	78	34	2	114	114
September	77	7	2	86	86
October	84	15	....	99	99
November	63	....	....	63	63
December	60	2	....	62	62
Total	748	115	15	878	878

LOCK NO. 3.

January	17	4	1	22	21
February	39	1	1	41	41
March	62	2	....	64	62
April	65	7	7	79	75
May	66	5	8	79	79
June	74	9	5	88	83
July	65	5	11	81	78
August	76	23	10	109	94
September	81	6	6	93	89
October	84	18	8	110	97
November	67	5	3	75	74
December	60	4	....	64	64
Total	756	89	60	905	857

LOCK NO. 4.

January	3	3	1	7	7
February	23	4	3	30	30
March	18	4	3	25	25
April	32	2	15	49	44
May	38	....	6	44	44
June	39	13	14	66	61
July	35	2	3	40	38
August	32	6	16	54	54
September	32	2	15	49	46
October	60	19	19	98	86
November	47	9	5	61	61
December	36	1	9	46	43
Total	395	65	109	569	539

LOCK NO. 5.

February	9	2	....	11	10
March	9	2	2	13	12
April	10	....	3	13	13
May	10	....	5	15	13
June	17	6	13	36	29
July	13	2	5	20	19
August	16	6	9	31	26
September	26	2	20	48	44
October	33	15	9	57	42
November	19	10	1	30	24
December	8	....	....	8	8
Total	170	45	67	282	240

Commerce of Muskingum River, etc.—Continued.

LOCK NO. 6.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
February	9	2	1	12	11
March	9	2	1	12	11
April	12	2	6	20	20
May	11	....	8	19	17
June	17	4	16	37	30
July	13	....	12	25	25
August	20	8	6	34	29
September	30	8	8	46	44
October	35	21	10	66	54
November	23	15	5	43	36
December	8	....	4	12	12
Total	187	62	77	326	289

LOCK NO. 7.

March	7	3	2	12	12
April	11	2	10	23	23
May	11	....	10	21	19
June	21	10	15	46	40
July	11	2	10	23	23
August	20	8	14	42	39
September	35	5	19	59	56
October	36	7	13	56	50
November	17	6	11	34	32
December	8	....	....	8	8
Total	177	43	104	324	302

LOCK NO. 8.

January	6	....	....	6	6
February	25	1	....	26	26
March	62	....	....	62	62
April	63	2	3	68	68
May	70	4	26	100	98
June	73	3	16	92	91
July	71	2	9	82	82
August	78	4	5	87	85
September	91	6	3	100	96
October	84	5	1	90	90
November	73	2	13	88	88
December	55	4	....	59	59
Total	751	33	76	860	851

LOCK NO. 9.

January	6	....	....	6	6
February	25	2	....	27	27
March	62	....	4	66	66
April	63	1	15	79	76
May	72	5	9	86	82
June	65	5	23	93	90
July	73	2	11	86	86
August	83	11	22	116	104
September	99	21	3	123	119
October	81	11	6	98	87
November	70	3	7	80	79
December	61	12	3	76	70
Total	760	73	103	936	892

Commerce of Muskingum River, etc.—**Continued.**

LOCK NO. 10.

Month.	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
January	6	....	....	6	6
February	25	....	....	25	25
March	61	....	1	62	62
April	62	1	1	64	64
May	65	7	....	72	67
June	74	7	3	84	83
July	68	2	1	71	71
August	91	5	2	98	95
September	95	11	2	108	105
October	73	5	2	80	79
November	63	1	1	65	64
December	55	23	1	79	73
Total	738	62	14	814	794

SUMMARY.

Lock No.—	Steamboats.	Barges.	Miscellaneous.	Total.	Number of lockages.
1	716	249	242	1,207	1,207
2	748	115	15	878	878
3	756	89	60	905	857
4	395	65	109	569	539
5	170	45	67	282	240
6	187	62	77	326	289
7	177	43	104	324	302
8	751	33	76	860	851
9	760	73	103	936	892
10	738	62	14	814	794
Total	5,398	836	867	7,101	6,849

List showing amount of principal items of freight and the number of passengers carried on the Muskingum River for the calendar year ending December 31, 1896.

Articles.	Amount.	Articles.	Amount.
Passengers ....number..	42,470	Lumber ....tons..	14,765
General merchandise ....tons..	18,535	Brick ....do....	845
Coal ....do....	10,357	Hay ....do....	1,215
Live stock ....do....	2,250	Salt ....do....	634
Oil ....do....	406	Potatoes ....do....	186
Wheat ....do....	3,448	Sand ....do....	4,305
Corn ....do....	384	Stone ....do....	2,212
Wool ....do....	110		

The total commerce was 59,597 tons of freight, valued, approximately, at $2,302,519, and the number of passengers carried 42,470.

List of steamboats (stern-wheel) plying on the Muskingum River between Zanesville and Marietta, Ohio.

Name of steamer.	Length.	Breadth.	Depth.	Draft.	Tonnage.
	Feet.	*Feet.*	*Feet.*	*Inches.*	
Lorena	141	32	5	24	287
Eliza H	110	22	8½	19	66
Hazel Rice	126	22½	4	26	138
T. M. Bayne	120	24	8½	20	115
Sonoma	125	20	3½	23	116
Leroy	121	22	8¾	28	142
Jewel	116	26	8½	24	95
Del Norte	35¾	8½	4¾	40	5
A. H. Lawrence	42	7	3½	30	3
W. H. Hart	38½	7½	8	30	4
Burnadina King	90	18	8½	24	106
Catharine Davis *a*	135½	27	8½	22	210
Barnsdall *a*	130	26	4	80	127
Valley Belle *a*	127	22	3½	27	127
D. T. Watson *a*	99	17	3½	29	81
Venus*	90	18	8½	20	116
Mary E. *a*	80	13½	8	30	19
Eliza *a*	110	25	3⅝	22	95
Will J. Cummings *a*	160	30	4	20	281
Troubadour *a*	100	18	8	22	60
Lulu F.*	85	18	8	20	40
Manhattan *a*	90	14	7½	60	90
Adelle *a*	130½	23	8½	60	90

a Only occasional trips on the Muskingum River.

[Extract from report of Mr. Edmund Moeser.]

All work was done in accordance with the approved project for the year and for incidental repairs rendered necessary by accident.

The locks have been successfully operated without interruption, except that caused by the failure of the floor in chamber of Lock No. 1, at the mouth of the river. On account of this accident, navigation between the Muskingum and Ohio rivers was suspended twenty-nine days during September and October, 1896, but, as the lock was practically inaccessible at that time on account of low water in the Ohio, the delay occasioned by the failure was unimportant to commerce.

The river was closed by ice for a period of fourteen days during January and February, 1897.

Although the past year was remarkably wet, none of the locks, with the exception of No. 1, were submerged by floods.

The following is a detailed statement of work done during the year:

LOCKS AND DAMS.

Lock and Dam No. 1, Marietta.—The frequent freshets which occurred throughout the year entailed repeated cleaning of walls and lock machinery of the deposits of sediment by the river. Incidental repairs were made for replacing two broken gear wheels on lower gate machinery, two pinions and all valve-stem levers on middle gates; repairing the implements used for cleaning mud from lock chamber, and repairing and repainting the lockmaster's house.

On September 7, 1896, about 4,000 square feet of the concrete floor at upper end of lock was suddenly destroyed by the hydrostatic pressure due to excess of head against bottom of lock. In addition to damaged floor, a large hole had been excavated in the soft material under the upper miter sill, the scour reaching a depth of 32 feet below normal level of pool, and there was enough leakage under the river wall to unfit the lock for use.

The floor in the lower half of the lock, as well as for some distance above the middle miter sill, was intact and apparently in good condition. Steps were immediately taken to provide for the temporary use of the entire lock chamber until the new middle gates, then in course of construction, could be finished. With the assistance of the Muskingum River dredge, tight material was filled into the cavities under lock and banked up against the upper miter wall and around the upper end of river wall. This material consisted of 8,851 cubic yards of sand and gravel and 355 yards of stone spalls. The top of the filling was protected with riprap where subject to the action of currents. The action of this material has so far been entirely successful in preventing the infiltration of water underneath the lock, but the reconstruction of the damaged floor is recommended, for the reason that the water is liable to again find its way underneath the lock and cause an upward pressure. Even if this could be prevented, the scour of the water discharged into the upper chamber, while filling lock, would soon result disastrously to the lock bottom.

The work of filling around lock was interrupted five days by high water. It was completed and the lock was again ready for use October 8, 1896. The new middle gates were placed in position October 21, since which date the one-half lock has been used almost exclusively, occasional lockings through the whole chamber being made when the head at dam did not exceed 5 or 6 feet.

Additional timbers were framed for use in making repairs to the upper gates of lock; but as these timbers will be needed in the construction of coffers, in case repairs are made to floor, the projected reconstruction of the upper gates has been postponed.

Lock and Dam No. 2, Devols.—The joints over 1,163 square feet of the lock masonry were raked out and repointed and some concrete repairs made on faces of walls. Deposits of sediment were removed from the lock chamber when required. Minor repairs were made to the gate-operating machinery, and the lock master's house, storehouse, and lock gates were repainted.

Lock and Dam No. 3, Lowell.—Rebuilt the protection crib below right abutment of dam. The dimensions of this crib are, 12 feet wide, 6 feet high, and 80 feet long. The amount of materials expended was 8,500 feet B. M., oak timber, 640 pounds driftbolts, and 149 cubic yards stone.

A freshet in July, 1896, caused a breach in the embankment back of the right abutment of dam. A brush-and-stone coffer was promptly thrown around the break, the débris, including part of an old timber conduit, removed, and the embankment refilled with 417 cubic yards of earth.

With the exception of repainting the storehouse, cleaning lock gates, and cutting grass over canal banks, no work was necessary at lock, dam, or canal.

Lock and Dam No. 4, Beverly.—The head gates and conduit to mill race were repaired and made tight; 142 cubic yards of stone was filled over the brush and stone extension to the right abutment of dam, and 300 cubic yards of earth was used to refill embankment back of the right abutment to its original elevation. A collapsed stone buttress at upper end of the land wall of lock was rebuilt with concrete, and 4 yards of earth was filled over a low point on canal bank near lock.

The many freshets during the year necessitated frequent cleanings of sediment from lock and drift from canal.

The lock gates and storehouse were repainted.

Lock and Dam No. 5, Luke Chute.—Rebuilt the rear of the lock-master's house, thereby completing the entire reconstruction of the building. The continued high water during the year gave no opportunity of making the projected repairs to lower apron of dam, and nothing was done except the collection of some needed materials. The lock and dam have been kept in serviceable condition.

Lock and Dam No. 6, Stockport.—The superstructure of the guide crib below land wall of lock, 195 feet in length, was rebuilt to a height of 5 feet below top of lock walls. The following amounts of materials were expended on the work:

White oak timber	feet B. M..	17,120
Stone	cubic yards..	460
Driftbolts	pounds..	4,600

Lock and Dam No. 7, McConnelsville.—The excessive leakage through cross wall and embankment behind the right abutment of dam has been threatening for some years to result in a break. Frequent unsuccessful attempts having been made to stop the leakage with timbers, stone, and gravel placed above the cross wall, it was accomplished during the past year by excavating below the cross wall down to rock bottom, filling the area of an old culvert along back of abutment with an 8 by 10 by 11 feet concrete block, and building a concrete core wall between the cross wall and embankment, from top of culvert to a level with the top of abutment; the dimensions of this wall are 4 feet thick at base, 2.5 feet at top, 14 feet high, and 26 feet long. The coping and masonry on abutment, down to a depth 3 feet below top, was relaid with concrete. The total volume of concrete placed is 91 cubic yards, about one-half of this being large pieces of rubblestone built into the sand and gravel concrete. The total amounts of ingredients mixed were 200.75 cubic feet Portland cement, 54.50 cubic yards sand and gravel, and 46 cubic yards rubblestone, which made 91 yards masonry in place, costing $383.91, or $4.22 per cubic yard.

Three hundred and eighty-five yards of sand and gravel was used for filling around the upper end of abutment and over embankment back of it. Other operations at this locality were for constructing an earth embankment paved with stone, 70 feet in length, near the head of bank between canal and river, the object of this work being to prevent overflow and make the canal available to navigation until floods reach the navigable high-water line of river. The amounts of materials required were 104 cubic yards earth and 40 yards stone. A washout on the lower slope of the terreplein at lock was refilled with 20 yards of stone. The drift was removed from canal after each flood, and lock and guard gates were kept in good condition by cleaning and painting. In the storeyard at this point the engines and boiler for floating pile driver were cleaned and repaired, and new rakes were put on one of the Government barges.

Lock and Dam No. 8, Eagleport.—Repairs were made to lock walls; they consisted in relaying 36 square feet of coping, and rebuilding with concrete the projecting platform for gate-operating machine at upper end of the river wall. The mud has been repeatedly cleaned from the lock chamber; the lock-master's house was repainted, and the iron filling plates on lower miter sill were refastened to the timber cushions.

The action of the eddy below the right abutment of dam had undermined the crib extension of this abutment until there was danger of collapse of the works and break around end of dam; the cutting extended under the embankment back of abutment, and partial failure of the crib below abutment had taken place. Immediate danger of a break was averted by filling stone, in pieces measuring from 12 to 34 cubic feet contents, around the lower end of abutment and under crib and embankment, the amount of stone thus used being 725 cubic yards. Additional repairs are required to insure stability of dam and abutment.

Lock and Dam No. 9, Taylorsville.—The damage to dam existing at beginning of the year was considerably augmented by a flood which occurred during the latter part of July, 1896. The top of the dam next to the lock was entirely destroyed over a length of 162 feet. A low brush-and-stone coffer was placed around this break and the dam rebuilt; the stone in coffer, mixed with gravel, was used for backing the new section of dam.

The following is the total amount of material expended in this work:

Timber	feet B. M..	38,378
Stone	cubic yards..	668
Driftbolts	pounds..	5,260
Brush	cords..	300
Gravel	cubic yards..	440

The old lateral canal at this place, though practically abandoned for navigation, is maintained at its upper end for the purpose of furnishing water to the one existing mill on its banks. It had to be twice cleaned out over a distance of about 400 feet.

The lock-master's office and lock irons were repainted and minor repairs made to machinery of lock.

Lock and Dam No. 10, Zanesville.—The reconstruction of this lock having been indefinitely postponed, all repairs are with a view of keeping it in operation without costly work. The lock is now in fair condition, due to repairs continued over several years, and the time required for boats passing the double-lift lock has been reduced from thirty-five to seventeen minutes.

During the past year the work on lock was for cleaning out cavities on face of walls, caused by disintegration of the stone, and filling them with concrete; the joints over an area of 8,421 square feet were repointed; new machines for operating the upper gates were made and placed in position; the wooden platforms at upper end of lock were replaced with 6¼ yards of concrete, and 364 feet of the coping was renewed.

Repairs made to the dam consisted in rebuilding 120 feet of the lower apron, 20 feet wide and 10 feet high, and resheeting the second step over a length of 65 feet. A serviceable coffer for this work was made of boards set on crest of dam and backed with earth and gravel. On account of frequent interruptions by high water the projected repairs were not completed, operations being with a view to securing the temporary safety of the dam.

The following materials were expended:

Timber	feet B. M..	35,100
Stone	cubic yards..	600
Driftbolts	pounds..	4,900

The storehouse and lock gates were repainted and canal banks kept in good condition.

BOATS.

The U. S. dredge *Malta* has been usefully employed in dredging out deposits of sediment from canals and making excavations through shoals in open river; snags, piling, and rocks were removed from channel, and dams backed with gravel where required. The work accomplished by the dredge in filling material around upper end of Lock No. 1 very materially reduced the cost of these repairs.

The operations of the dredge extended from the mouth of river to Zanesville, the following points receiving attention: At No. 1, Marietta, channel from mouth of river to lock, and 7,710 yards of gravel filling around lock; at No. 2, Devols, the upper and lower approaches to lock, and gravel for dam; at No. 3, Lowell, the canal; at Baldwins Ripple, 1¼ miles below No. 5, the upper end of bar; at No. 6, Stockport, the upper approach to lock; at No. 7, McConnelsville, the canal and its upper approach; at No. 8, Eagleport, the approaches to lock, and 7,032 cubic yards for backing dam; at No. 9, Taylorsville, the bar below old lock, the head of canal, and channel below new lock; at No. 10, Zanesville, the lower approach to lock and canal.

The dredging during the year extended over a distance of 13,000 feet.

The annual repairs to machinery of dredge were made from January to May, 1897.

The towing for the dredge was done by the hired steamboat *Hazel Rice*.

The Government steamer *Vega* has been of great service in towing the material needed on the works and serving as dredge tender at the beginning of the present season.

The floating pile driver was accidentally damaged to the extent that it was necessary to dismantle the boat. The hull is old and unfit for use. It is therefore proposed to rebuild it during the present season.

LAND.

A lease was issued to Lewis H. Krier for $5\frac{20}{100}$ acres of land at old Lock No. 9, Taylorsville, Ohio.

BRIDGES.

The Secretary of War under date of December 8, 1896, granted permission to the Cincinnati and Muskingum Valley Railway Company to build temporary false work in the channel of the canal under its bridge at Zanesville, Ohio. This false work was constructed, the old wooden drawbridge spanning the canal was replaced with an iron structure, and the false work removed without interfering with navigation.

C C 7.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS—OBSERVATIONS ON MUSKINGUM RIVER.

Pursuant to the desire of Capt. Lansing H. Beach, Corps of Engineers, for accurate and reliable data upon the form of surface of water backed up by a dam in a running stream, the Chief of Engineers, under date of September 27, 1895, stated that there was a great want of information on this subject, and allotted $700 from the appropriation for examinations, surveys, and contingencies of rivers and harbors, for obtaining the required data on the Muskingum River.

The recording of gauge readings began December 21, 1895, and was suspended November 1, 1896.

Four sheets of profiles showing the characteristic results of the observations were transmitted to the Chief of Engineers with letter dated June 18, 1897.

The total cost of the work was $622.28.

Appended are extracts from the reports of Mr. Edmund Moeser, assistant engineer, under whose direction the work was done.

[Extracts from reports of Mr. Edmund Moeser.]

A transit and level line was run over the stretch of river between Locks Nos. 9 and 10, a distance of 8.111 miles, and bench marks established near proposed gauge stations. The levels were run very carefully and checked on the permanent bench marks at both ends of line.

The survey of river from Zanesville to Dresden, Ohio, made during the previous winter, was used to establish gauges in pool above Dam No. 10.

Wooden gauges were made and placed at intervals of about 5,000 feet between Locks Nos. 9 and 10 and for a distance of about 4 miles above Dam No. 10. The total number of gauges established was 14.

Beginning December 21, 1895, the readings on gauges in Pool No. 9 were recorded from one observation daily.

No floods occurred during the period from December, 1895, to June, 1896, the highest reading at Dam No. 9 showing a depth of but 5.20 feet on crest of dam. The observations were therefore continued until sufficient additional data were obtained to establish the form of surface of water at high stages of river.

Pool No. 9 was selected for the observations on account of its having the least abrupt changes in the alignment over its course, and Pool No. 10 for the reason that there is a dam at the lower end only.

The variation of level in the cross section of the surface due to rising and falling river, ununiform width of river, change of maximum velocity of current from one side to the other, obstructions caused by bridges, and discharge from intermediate smaller streams affects the inclination of surface to an uncertain degree. Account should also be taken of the errors in gauge readings ascribed to waves translated to the water around gauges.

C C 8.

PRELIMINARY EXAMINATION OF OHIO RIVER FROM MARIETTA, OHIO, TO ITS MOUTH.

[Printed in House Doc. No. 125, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1896.

SIR: The river and harbor act of June 3, 1896, in section 9, directed a number of surveys to be made, among them the Ohio River from Marietta to its mouth. The very limited amount provided by Congress for making the surveys mentioned in this section of the act did not warrant the allotment to this item of a sum anything like sufficient to pay the expenses of a proper survey of the river between the points named, even if the field and office work were carried on in the most economical and inexpensive manner; and with a view of executing as far as practicable the wishes and intentions of Congress, the Secretary of War decided that this item of the act should be treated as a preliminary examination, and that a report be prepared giving an estimate of the cost of the survey desired.

The total amount appropriated in the last river and harbor law for examinations and surveys all over the United States was but $200,000. A survey of the portion of the Ohio River from Marietta to its mouth is estimated to cost $119,250.

I have the honor, therefore, to submit and ask attention to the accompanying copy of report of November 27, 1896, by Maj. W. H. Heuer, Corps of Engineers, upon an examination of Ohio River from Marietta to its mouth, made in lieu of the survey contemplated.

It is the opinion of Major Heuer that this portion of the river is worthy of improvement, and that, in view of the facts set forth in his report, no detailed survey of the entire length of river from Marietta to its mouth is at present necessary or desirable. His views are concurred in by Col. Henry M. Robert, Corps of Engineers, the division engineer, and by me.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, November 27, 1896.

GENERAL: The river and harbor act of June 3, 1896, provided, among other things, in section 9—

> That the Secretary of War is hereby directed, at his discretion, to cause surveys to be made and the cost of improvement to be estimated at the following localities, to wit:
>
> * * * * * * *
>
> Ohio River, Marietta to its mouth.

By letter from the Chief of Engineers dated September 8, 1896, I was advised that upon the recommendation of the Chief of Engineers the Secretary of War had ordered a preliminary examination of this portion of the Ohio and a report to be submitted, giving an estimate of the cost of the survey desired. By the same letter I was charged with the duty of making this preliminary examination and report, and the sum of $50 was allotted with which to pay the necessary expenses connected therewith.

In compliance with the above, I have now to submit the following report:

All of the Ohio River between Marietta and its mouth has been examined at various times, either by the officers in charge or by some of their assistants, while engaged in making or planning improvements thereon. The whole river has been surveyed, and was charted under the direction of the late Col. W. E. Merrill, Corps of Engineers. The maps were made from surveys commenced in 1837 and continued with various interruptions up to 1881. They show all important islands, the banks, towns, landings, and the improvements made in the river prior to June, 1881. In addition, there are in this office numerous maps of special localities along the river.

It is estimated that a complete detailed survey of the Ohio River between Marietta and its mouth would cost at the rate of $150 per mile, and as the distance is 795 miles the total cost of such survey would be $119,250. Whether or not the information gained by the resurvey of the river would be of sufficient value to warrant this expenditure is a question which admits of discussion.

There is at present in progress a detailed survey from Pittsburg to Marietta, 171 miles, provided for by a special appropriation of $25,000 in the act of June 3, 1896. The necessity for the survey of this portion of the river is due to the fact that part of this distance, and perhaps all of it, may be improved by a system of locks and movable dams. For such a contemplated method of improvement it is necessary to determine with considerable accuracy the differences of level at various points along the river.

Below Marietta it is not at all certain—in fact hardly probable, owing to the reduced slope of the river—that slack-water improvement of the Ohio River will be required; but even if a survey below Marietta should be made and continued to the mouth of the river, and slack-water improvement over any or all of the 795 miles should be indicated as the proper treatment of the river, a separate and very much more detailed survey would have to be made at each and every locality at which a lock would probably be built or other improvement designed before a detailed plan and estimate for that particular locality could be submitted.

Between Marietta and its mouth the Ohio River flows through an exceedingly fertile country. Many important towns and several large cities are located on its banks. The slope of the river is gentle and fairly uniform, except at the falls at Louisville, Ky., where special works have been undertaken and successfully executed. The low-water navigation is obstructed by numerous shallow bars of sand and gravel, sometimes cemented, but generally loose and readily moved. The project heretofore recommended and approved for the treatment of this portion of the river has contemplated dams in back channels of islands, confining the low-water flow to a single channel, and low dikes to contract the width of the river in wide places, thus concentrating the low-water discharge and inducing scour, supplemented by dredging where needed, and by the removal of all sunken obstructions, such as wrecks and snags.

This river carries an immense commerce—if calculated by mile tons, possibly the largest in the United States—and is emphatically worthy of improvement, but it is believed that the work should be continued in the same manner as above outlined.

As above stated, special surveys for the improvement of certain localities have been made in the past and will necessarily be required in the future. These surveys are properly chargeable to and have been generally paid for from the general appropriation for improving the river. They will contain all the information needed to enable plans of improvement at these localities to be intelligently devised.

As stated in my annual report for 1896, in work such as is being undertaken for the improvement of this portion of the Ohio River it is impossible to determine in advance just where and how much work will be needed for making good navigation upon the entire length of the river, and it is therefore impossible to submit an estimate of the cost of complete improvement.

A resurvey of the portion of the river above considered would not furnish sufficient information to enable an intelligent estimate of the total cost to be made.

In view of the above facts, and after careful consideration, I am of the opinion that no detailed survey of the entire length of river from Marietta to its mouth is at present necessary or desirable.

Very respectfully, your obedient servant,

W. H. HEUER,
Major of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, December 2, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the views and conclusions of Major Heuer that the Ohio River from Marietta to its mouth is worthy of improvement and that a survey is at present not desirable or necessary.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

APPENDIX D D.

IMPROVEMENT OF MONONGAHELA AND ALLEGHENY RIVERS, WEST VIRGINIA AND PENNSYLVANIA.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, MAJ. CHAS. F. POWELL AND MAJ. R. L. HOXIE, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Monongahela River, West Virginia and Pennsylvania.
2. Operating and care of Locks and Dams Nos. 8 and 9, Monongahela River.
3. Purchase of Lock and Dam No. 7, Monongahela River.
4. Purchase of Lock and Dam No. 6, Monongahela River.
5. Condemnation of property and appurtenances of the Monongahela Navigation Company.
6. Allegheny River, Pennsylvania.
7. Construction of locks and dams at Herr Island, above the head of Six Mile Island, and at Springdale, Allegheny River.

UNITED STATES ENGINEER OFFICE,
Pittsburg, Pa., July 17, 1897.

GENERAL: I have the honor to transmit herewith the annual reports of the works under my charge for the year ending June 30, 1897.

I relieved Maj. R. L. Hoxie, Corps of Engineers, of the charge of these works on April 10, 1897, pursuant to War Department orders.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

D D 1.

IMPROVEMENT OF MONONGAHELA RIVER, WEST VIRGINIA AND PENNSYLVANIA.

The part of the Monongahela River above the pool of Lock and Dam No. 7 belonging to the Monongahela Navigation Company is under control of the General Government. Several years ago the United States built Locks and Dams Nos. 8 and 9, which carried slack water to Morgantown, W. Va., and made that place the head of packet and all ordinary navigation.

The river and harbor act of 1896 provided for the extension of slack water by the construction of six locks and dams from Morgantown to Fairmont, W. Va., 25 miles upstream, the principal object being to afford water transportation for coal from mines near Fairmont.

A site for the first new lock and dam, No. 10, had been selected from an examination and survey in 1896.

During the last fiscal year levels were run from Lock No. 9 to Fairmont. Examinations and surveys were made for sites for the locks, dams, and abutments, and lands needed therefor, as follows: No. 11, at Morgans Mill; No. 12, at Jimmys Ripple; No. 13, at Trippetts Ripple; No. 14, at Lowsville, and No. 15 about 1 mile above Rivesville.

A general project for the improvement was prepared, the work advertised for bids under the continuing-contract system, and the contract awarded.

Subsequently the line of levels was duplicated from Lock No. 9 to Hoults, elevations adopted, and permanent bench marks established.

The lock lifts for overcoming the fall of 64 feet from Fairmont to Pool No. 9 are to be 10 and 12 feet. The locks and dams will be made of concrete. The useful capacity of the lock chambers will be 56 by 177 feet by 7 feet depths on the lower sills, at pool levels, and 8 feet on the upper sills at same.

The project was prepared by Maj. R. L. Hoxie, Corps of Engineers, engineer in charge.

The titles to the land needed have not yet been secured.

The other portion of the Monongahela River over which the United States had exercised control extends from the mouth of the river to Lock No. 1 of the Monongahela Navigation Company, a distance of 2 miles, and lying in the pool of the Davis Island Dam of the Ohio River.

This reach of river comprises a most useful part of Pittsburg Harbor. Two shoals lying in it give much trouble to navigation whenever the wickets of Davis Island Dam are down during a low stage of river, which occasionally is unavoidable, or when the pool falls below normal level from lack of water, as may happen from a long dry season. Even at the pool level there is not deep enough water on these flats or shoals for the 7 and 8 feet draft boats used in coal tows.

The first of these shoals is under and next below the Smithfield Street Bridge, 0.8 mile above the river mouth; the other is Pipetown Bar, 0.4 mile farther upstream, and situated about midway between the Smithfield Street and Panhandle Railroad bridges.

In 1895 a Board of Engineers convened for the purpose recommended certain harbor lines for Pittsburg Harbor, which were adopted by the War Department. The Board also recommended that certain necessary surveys be made and monuments placed to mark base lines to which the harbor lines might be referred, and explained that a difference of 1 foot in elevation of the line means a difference of 3 feet horizontally. The recommendations and views of the Board were approved, but no means have been provided for carrying them out.

While riparian owners have naturally been prompt to fill out to the harbor line, bank projections or fillings and abandoned structures outside of the line remain untouched. Many cases of illegal dumping over the river bank continue to occur, through ignorance of the law or location of the harbor line and otherwise. An enormous amount of waste is made by mills and furnaces at and near Pittsburg, whose disposal by dumping in the adjacent river is tempting from its convenience and the making of available land. Steam railroads as well as the mills have greatly encroached upon the river, while street and other city refuse is disposed of to a greater or less extent by dumping over the river banks, from whence it is washed down or away by freshets to shoal the shore channels or help to build bars.

The prevention, to any considerable extent, of these unauthorized encroachments upon and illegal dumpings into the river requires patrol, inspection, and investigation.

During the year five informations were given to the United States district attorney of illegal structures built beyond the harbor line, or dumpings over the river bank, at the harbor of Pittsburg. One of the cases was dismissed for want of evidence; the parties in the other cases were held by the United States commissioner for trial, which has not yet been had.

There has been no appropriation for the lower part of the Monongahela River and no provision of funds specifically for this or other part of Pittsburg Harbor.

By means of an allotment of funds 2,000 yards of material was dredged from the shoal at Smithfield Street Bridge during low water of last summer. During the early part of last June much difficulty was experienced by boats in passing this place on account of its shoalness. The Morgantown packets could not run to their wharf boat below the Smithfield Street Bridge for more than a week, and coal boats could not be taken over the shoal for a longer time.

Money statement.

July 1, 1896, balance unexpended	$70, 346. 24
Amount appropriated by sundry civil act approved June 4, 1897	350, 000. 00
	420, 346. 24
June 30, 1897, amount expended during fiscal year	1, 135. 19
July 1, 1897, balance unexpended	419, 211. 05
July 1, 1897, outstanding liabilities	4, 447. 37
July 1, 1897, balance available	414, 763. 68
Amount (estimated) required for completion of existing project	775, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1899	387, 500. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

June 10, 1872	$25, 000
March 3, 1873	66, 000
June 23, 1874	25, 000
March 3, 1875	22, 000
June 18, 1878	25, 000
March 3, 1879	24, 000
June 14, 1880	25, 000
March 3, 1881	25, 000
August 2, 1882	25, 000
July 5, 1884	45, 000
August 5, 1886	90, 900
August 11, 1888	35, 000
September 25, 1889 (allotted from appropriation for examinations, surveys, and contingencies of rivers and harbors)	4, 000
July 13, 1892	25, 000
August 17, 1894	20, 000
June 3, 1896	30, 000
June 4, 1897	350, 000
Total	861, 900

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, in the Monongahela River, between Morgantown and Fairmont, W. Va., opened at 12 m., April 27, 1897, by Maj. Charles F. Powell, Corps of Engineers.

LOCK NO. 10.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$10.00		$25.00		$1.00
Excavation:							
Earth ......cubic yards..	7,421	$0.35	2,597.35	$0.25	1,855.25	$5.00	37,105.00
Hardpan		.80		.40		5.00	
Rock ......cubic yards..	1,462	2.00	2,924.00	1.00	1,462.00	5.00	7,310.00
Embankment ......do....	2,370	.35	829.50	.20	474.00	.30	711.00
Concrete:							
Natural cement ......do....	4,686	5.29	24,788.94	4.90	22,961.40	7.00	32,802.00
Portland cement ......do....	9,557	7.39	70,626.23	6.70	64,031.90	9.00	86,013.00
Stone filling in cribs ......do....	2,674	1.10	2,941.40	1.50	4,011.00	1.50	4,011.00
Stone paving of—							
Cribs ......square yards..	234	1.75	409.50	1.75	409.50	1.20	280.80
River bank ......do....	1,970	.90	1,773.00	2.00	3,940.00	1.20	2,364.00
White oak in—							
Gates ......feet B. M..	52,192	55.00	2,870.56	50.00	2,609.60	50.00	2,609.60
Quoins and sills ......do....	7,386	55.00	406.23	50.00	369.30	50.00	369.30
Cribs and gate spars ......do....	113,160	24.00	2,715.84	28.00	3,168.48	30.00	3,394.80
Driftbolts ......pounds..	7,440	.03½	260.40	.02½	186.00	.02½	186.00
Total			113,152.95		105,503.48		177,157.50
Samples:							
Sand		Poor		Good		Excellent.	
Stone		do		do		Fair.	

Material.	Quantity.	No. 6.—Hulings Bros., Pittsburg, Pa.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$675.00		$500.00		$200.00
Excavation:							
Earth ......cubic yards..	7,421	$1.15	8,534.15	$0.80	5,936.80	$0.50	3,710.50
Hardpan		2.00		1.90		1.00	
Rock ......cubic yards..	1,462	2.00	2,924.00	2.90	4,239.80	2.00	2,924.00
Embankment ......do....	2,370	1.25	2,962.50	.50	1,185.00	.50	1,185.00
Concrete:							
Natural cement ......do....	4,686	6.00	28,116.00	7.80	36,550.80	7.25	33,973.50
Portland cement ......do....	9,557	8.25	78,845.25	10.05	96,047.85	9.25	88,402.25
Stone filling in cribs ......do....	2,674	1.35	3,609.90	2.00	5,348.00	2.00	5,348.00
Stone paving of—							
Cribs ......square yards..	234	2.40	561.60	4.00	936.00	2.25	526.50
River bank ......do....	1,970	2.10	4,137.00	4.00	7,880.00	2.25	4,432.50
White oak in—							
Gates ......feet B. M..	52,192	65.00	3,392.48	65.00	3,392.48	100.00	5,219.20
Quoins and sills ......do....	7,386	65.00	480.09	65.00	480.09	100.00	738.60
Cribs and gate spars ......do....	113,160	40.00	4,526.40	40.00	4,526.40	30.00	3,394.80
Driftbolts ......pounds..	7,440	.03	223.20	.03½	260.40	.04	297.60
Total			138,987.57		167,283.62		150,352.45
Samples:							
Sand		Fair		Excellent		No samples.	
Stone		do		Good			

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 10—Continued.

Material.	Quantity.	No. 9.—Keeling & Ridge, Pittsburg, Pa. a		No. 10.—The Houston Construction Co., Philadelphia, Pa. b		No. 12.—Owen Patterson & Patrick Kulty, Baltimore, Md.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$25.00		$25.00
Excavation:							
Earth ... cubic yards	7,421	$0.50	3,710.50	$0.39	2,894.19	$1.00	7,421.00
Rock ... cubic yards	1,462	2.50	3,655.00	1.57	2,295.34	3.00	4,386.00
Embankment ... do	2,370	.75	1,777.50	.31	734.70	.30	711.00
Concrete:							
Natural cement ... do	4,686	8.00	37,488.00	4.72	22,117.92	6.50	30,459.00
Portland cement ... do	9,557	10.50	100,348.50	7.30	69,766.10	9.00	86,013.00
Stone filling in cribs ... do	2,674	2.50	6,685.00	1.57	4,198.18	2.50	6,685.00
Stone paving of—							
Cribs ... square yards	234	1.50	351.00	1.96	458.64	1.00	234.00
River bank ... do	1,970	1.50	2,955.00	1.96	3,861.20	1.50	2,955.00
White oak in—							
Gates ... feet B. M.	52,192	70.00	3,653.44	78.50	4,097.07	35.00	1,826.72
Quoins and sills ... do	7,386	60.00	443.16	78.50	579.80	35.00	258.51
Cribs and gate spars ... do	113,160	35.00	3,960.60	44.00	4,979.04	35.00	3,960.60
Driftbolts ... pounds	7,440	.04	297.60	.05	372.00	.04	297.60
Total			165,425.80		116,879.18		145,232.43
Samples:							
Sand		Poor		Poor		No samples.	
Stone		Good		Excellent			

Material.	Quantity.	No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$50.00		$175.00
Excavation:							
Earth ... cubic yards	7,421	$0.70	5,194.70	$0.40	2,968.40	$5.20	38,589.20
Hardpan		1.00		.60		5.65	
Rock ... cubic yards	1,462	2.00	2,924.00	2.50	3,655.00	5.90	8,625.80
Embankment ... do	2,370	.26	616.20	.35	829.50	4.90	11,613.00
Concrete:							
Natural cement ... do	4,686	5.50	25,773.00	6.50	30,459.00	6.60	30,927.60
Portland cement ... do	9,557	7.25	69,288.25	8.75	83,623.75	8.75	83,623.75
Stone filling in cribs ... do	2,674	1.60	4,278.40	1.50	4,011.00	1.10	2,941.40
Stone paving of—							
Cribs ... square yards	234	2.00	468.00	2.50	585.00	1.50	351.00
River bank ... do	1,970	1.75	3,447.50	2.50	4,925.00	1.25	2,462.50
White oak in—							
Gates ... feet B. M.	52,192	66.00	3,444.67	80.00	4,175.36	57.00	2,974.94
Quoins and sills ... do	7,386	66.00	487.48	80.00	590.88	90.00	664.74
Cribs and gate spars ... do	113,160	40.00	4,526.40	40.00	4,526.40	37.00	4,186.92
Driftbolts ... pounds	7,440	.02½	186.00	.04	297.60	.05	372.00
Total			120,734.60		140,696.89		187,507.85
Samples:							
Sand		Good		Good		Fair.	
Stone		Fair		Fair		Excellent.	

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a Sample of stone No. 2 for concrete for Locks and Dams 10, 11, and 13, additional 25 cents per cubic yard. Sample is brown limestone, rated excellent.

b The Houston Construction Company, by letter dated April 26, 1897, accompanying bid, will accept 5 per cent less than sum of separate bids—

If awarded Locks and Dams 10 to 15 inclusive, i. e., $699,615.18 less 5 per cent ($34,980.76)= $664,634.42.

If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38)= $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81)= $317,636.51.

NOTE.—Samples rated according to quality as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 10—Continued.

Material.	Quantity.	No. 18.—Jas. McCarron, Philadelphia, Pa.		No. 20.—McArthur Bros. Co., Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$150.00		$3,000.00
Excavation:					
Earth ... cubic yards	7,421	$0.15	1,113.15	$1.60	11,873.60
Hardpan		.20			
Rock ... cubic yards	1,462	3.00	4,386.00	7.00	10,231.00
Embankment ... do	2,370	.15	355.50	.40	948.00
Concrete:					
Natural cement ... do	4,686	3.59	16,822.74	6.50	30,459.00
Portland cement ... do	9,557	5.74	54,857.18	8.20	78,367.40
Stone filling in cribs ... do	2,674	1.59	4,251.66	2.40	6,417.60
Stone paving of—					
Cribs ... square yards	234	3.00	702.00	3.00	702.00
River bank ... do	1,970	3.00	5,910.00	2.50	4,925.00
White oak in—					
Gates ... feet B. M.	52,192	40.00	2,087.68	60.00	3,131.52
Quoins and sills ... do	7,386	40.00	295.44	70.00	517.02
Cribs and gate spars ... do	113,160	35.00	3,960.60	30.00	3,394.80
Driftbolts ... pounds	7,440	.02¼	167.40	.05	372.00
Total			95,059.35		154,341.94
Samples:					
Sand		Poor		Excellent	
Stone		Excellent		Do.	

LOCK NO. 11.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$10.00		$25.00		$1.00
Excavation:							
Earth ... cubic yards	5,789	$0.35	2,026.15	$0.25	1,447.25	$3.50	20,261.50
Hardpan		.75		.40		3.50	
Rock ... cubic yards	2,256	2.00	4,512.00	1.00	2,256.00	3.50	7,896.00
Embankment ... do	4,234	.35	1,481.90	.20	846.80	.30	1,270.20
Concrete:							
Natural cement ... do	6,718	5.27	35,403.86	4.90	32,918.20	7.00	47,026.00
Portland cement ... do	12,275	7.37	90,466.75	6.70	82,242.50	9.00	110,475.00
Stone filling in cribs ... do	2,807	1.10	3,087.70	1.50	4,210.50	1.50	4,210.50
Stone paving of—							
Cribs ... square yards	301	1.75	526.75	1.75	526.75	1.20	361.20
River bank ... do	1,436	.90	1,292.40	2.00	2,872.00	1.20	1,723.20
White oak in—							
Gates ... feet B. M.	54,798	55.00	3,013.89	50.00	2,739.90	50.00	2,739.90
Quoins and sills ... do	7,950	55.00	437.25	50.00	397.50	50.00	397.50
Cribs and gate spars ... do	121,280	24.00	2,910.72	28.00	3,395.84	30.00	3,638.40
Driftbolts ... pounds	8,543	.03½	299.01	.02½	213.58	.02½	213.58
Total			145,468.88		134,091.82		200,213.98
Samples:							
Sand		Poor		Good		Excellent.	
Stone		do		Fair		Fair.	

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 11—Continued.

Material.	Quantity.	No. 5.—John J. Shipman, Washington, D.C.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$200.00		$1,000.00		$200.00
Excavation:							
Earth, cubic yards	5,789	$3.00	17,367.00	$0.80	4,631.20	$0.50	2,894.50
Hardpan		3.00		1.90		1.00	
Rock, cubic yards	2,256	3.00	6,768.00	2.90	6,542.40	2.00	4,512.00
Embankment, do	4,234	.50	2,117.00	.50	2,117.00	.50	2,117.00
Concrete:							
Natural cement, do	6,718	6.50	43,667.00	7.80	52,400.40	7.25	48,705.50
Portland cement, do	12,275	8.50	104,337.50	10.05	123,363.75	9.25	113,543.75
Stone filling in cribs, do	2,807	1.50	4,210.50	2.00	5,614.00	2.00	5,614.00
Stone paving of—							
Cribs, square yards	301	3.00	903.00	4.00	1,204.00	2.25	677.25
River bank, do	1,436	2.50	3,590.00	4.00	5,744.00	2.25	3,231.00
White oak in—							
Gates, feet B. M.	54,798	90.00	4,931.82	65.00	3,561.87	100.00	5,479.80
Quoins and sills, do	7,950	100.00	795.00	65.00	516.75	100.00	795.00
Cribs and gate spars, do	121,280	40.00	4,851.20	40.00	4,851.20	30.00	3,638.40
Driftbolts, pounds	8,543	.04	341.72	.03½	299.01	.04	341.72
Total			194,079.74		211,845.58		191,749.92
Samples:							
Sand		Poor		Excellent		No samples.	
Stone		do		Fair			

Material.	Quantity.	No. 9.—Keeling & Ridge, Pittsburg, Pa. *a*		No. 10.—The Houston Construction Co., Philadelphia, Pa. *b*		No. 12.—Owen Patterson and Patrick Kulty, Baltimore, Md.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$75.00		$25.00
Excavation:							
Earth, cubic yards	5,789	$0.50	2,894.50	$0.35	2,026.15	$1.00	5,789.00
Rock, do	2,256	2.50	5,640.00	1.40	3,158.40	3.00	6,768.00
Embankment, do	4,234	.75	3,175.50	.28	1,185.52	.30	1,270.20
Concrete:							
Natural cement, do	6,718	7.00	47,026.00	4.20	28,215.60	6.00	40,308.00
Portland cement, do	12,275	9.50	116,612.50	6.51	79,910.25	9.00	110,475.00
Stone filling in cribs, do	2,807	2.50	7,017.50	1.05	2,947.35	2.00	5,614.00
Stone paving of—							
Cribs, square yards	301	1.50	451.50	1.75	526.75	1.00	301.00
River bank, do	1,436	1.50	2,154.00	1.75	2,513.00	1.00	1,436.00
White oak in—							
Gates, feet B. M.	54,798	70.00	3,835.86	70.00	3,835.86	35.00	1,917.93
Quoins and sills, do	7,950	60.00	477.00	70.00	556.50	35.00	278.25
Cribs and gate spars, do	121,280	35.00	4,244.80	37.80	4,584.38	35.00	4,244.80
Driftbolts, pounds	8,543	.04	341.72	.04	341.72	.04	341.72
Total			193,970.88		129,876.48		178,768.90
Samples:							
Sand		Poor		Poor		No samples.	
Stone		Good		Excellent			

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a Sample of stone No. 2 for concrete for Locks and Dams 10, 11, and 13, additional 25 cents per cubic yard. Sample is brown limestone, rated excellent.

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If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38)= $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81)= $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 11—Continued.

Material.	Quantity.	No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$50.00		$100.00
Excavation:							
Earth ... cubic yards	5,789	$0.45	2,605.05	$0.30	1,736.70	$5.70	32,997.30
Hardpan		.75		.60		6.00	
Rock ... cubic yards	2,256	1.70	3,835.20	1.50	3,384.00	6.40	14,438.40
Embankment ... do	4,234	.26	1,100.84	.30	1,270.20	2.50	10,585.00
Concrete:							
Natural cement ... do	6,718	5.45	36,613.10	6.15	41,315.70	6.25	41,987.50
Portland cement ... do	12,275	7.20	88,380.00	7.90	96,972.50	8.40	103,110.00
Stone filling in cribs ... do	2,807	1.60	4,491.20	1.20	3,368.40	1.10	3,087.70
Stone paving of—							
Cribs ... square yards	301	2.00	602.00	2.00	602.00	1.50	451.50
River bank ... do	1,436	1.75	2,513.00	2.00	2,872.00	1.25	1,795.00
White oak in—							
Gates ... feet B. M	54,798	66.00	3,616.67	75.00	4,109.85	57.00	3,123.49
Quoins and sills ... do	7,950	66.00	524.70	75.00	596.25	90.00	715.50
Cribs and gate spars ... do	121,280	40.00	4,851.20	35.00	4,244.80	37.00	4,487.36
Driftbolts ... pounds	8,543	.02½	213.58	.04	341.72	.05	427.15
Total			149,446.54		160,864.12		217,305.90
Samples:							
Sand		Good		Good		Fair.	
Stone		Fair		Fair		Excellent.	

Material.	Quantity.	No. 18.—Jas. McCarron, Philadelphia, Pa.		No. 20.—McArthur Brothers Co., Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$150.00		$3,000.00
Excavation:					
Earth ... cubic yards	5,789	$0.15	868.35	$1.60	9,262.40
Hardpan		.20			
Rock ... cubic yards	2,256	3.00	6,768.00	5.00	11,280.00
Embankment ... do	4,234	.15	635.10	.40	1,693.60
Concrete:					
Natural cement ... do	6,718	3.59	24,117.62	6.50	43,667.00
Portland cement ... do	12,275	5.74	70,458.50	7.90	96,972.50
Stone filling in cribs ... do	2,807	1.59	4,463.13	2.40	6,736.80
Stone paving of—					
Cribs ... square yards	301	3.00	903.00	3.00	903.00
River bank ... do	1,436	3.00	4,308.00	2.30	3,302.80
White oak in—					
Gates ... feet B. M.	54,798	40.00	2,191.92	60.00	3,287.88
Quoins and sills ... do	7,950	40.00	318.00	70.00	556.50
Cribs and gate spars ... do	121,280	35.00	4,244.80	30.00	3,638.40
Driftbolts ... pounds	8,543	.02¼	192.22	.05	427.15
Total			119,618.64		184,728.08
Samples:					
Sand		Poor		Excellent.	
Stone		Excellent		Do.	

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 12.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$10.00		$25.00		$1.00
Excavation:							
Earth ... cubic yards	2,458	$0.30	737.40	$0.25	614.50	$3.50	8,603.00
Hardpan ... do	3,998	.60	2,398.80	.40	1,599.20	3.50	13,993.00
Rock ... do	1,060	1.75	1,855.00	1.00	1,060.00	3.50	3,710.00
Embankment ... do	4,082	.35	1,428.70	.20	816.40	.25	1,020.50
Concrete:							
Natural cement ... do	5,796	5.17	29,965.32	4.90	28,400.40	7.00	40,572.00
Portland cement ... do	12,270	7.27	89,202.90	6.70	82,209.00	9.00	110,430.00
Stone filling in cribs ... do	2,882	1.00	2,882.00	1.50	4,323.00	1.50	4,323.00
Stone paving of—							
Cribs ... square yards	301	1.60	481.60	1.75	526.75	1.20	361.20
River bank ... do	891	.80	712.80	2.00	1,782.00	1.20	1,069.20
White oak in—							
Gates ... feet B. M.	54,798	55.00	3,013.89	50.00	2,739.90	50.00	2,739.90
Quoins and sills ... do	7,950	55.00	437.25	50.00	397.50	50.00	397.50
Cribs and gate spars ... do	135,484	24.00	3,251.62	28.00	3,793.55	30.00	4,064.52
Driftbolts ... pounds	8,618	.03½	301.63	.02½	215.45	.02½	215.45
Total			136,678.91		128,502.65		191,500.27
Samples:							
Sand		Poor		Good		Excellent.	
Stone		do		Fair		Fair.	

Material.	Quantity.	No. 5.—John J. Shipman, Washington, D.C.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$200.00		$500.00		$200.00
Excavation:							
Earth ... cubic yards	2,458	$3.00	7,374.00	$0.80	1,966.40	$0.50	1,229.00
Hardpan ... do	3,998	3.00	11,994.00	1.90	7,596.20	1.00	3,998.00
Rock ... do	1,060	3.00	3,180.00	2.90	3,074.00	2.00	2,120.00
Embankment ... do	4,082	.50	2,041.00	.50	2,041.00	.50	2,041.00
Concrete:							
Natural cement ... do	5,796	6.50	37,674.00	6.70	38,833.20	7.40	42,890.40
Portland cement ... do	12,270	8.50	104,295.00	8.95	109,816.50	9.50	116,565.00
Stone filling in cribs ... do	2,882	1.50	4,323.00	2.00	5,764.00	2.00	5,764.00
Stone paving of—							
Cribs ... square yards	301	3.00	903.00	4.00	1,204.00	2.25	677.25
River bank ... do	891	2.50	2,227.50	4.00	3,564.00	2.25	2,004.75
White oak in—							
Gates ... feet B. M.	54,798	90.00	4,931.82	65.00	3,561.87	100.00	5,479.80
Quoins and sills ... do	7,950	100.00	795.00	65.00	516.75	100.00	795.00
Cribs and gate spars ... do	135,484	40.00	5,419.36	40.00	5,419.36	30.00	4,064.52
Driftbolts ... pounds	8,618	.04	344.72	.03½	301.63	.04	344.72
Total			185,702.40		184,158.91		188,173.44
Samples:							
Sand		Poor		Excellent		No samples.	
Stone		do		do			

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 12—Continued.

Material.	Quantity.	No. 10.—The Houston Construction Co., Philadelphia, Pa.[a]		No. 12.—Owen Patterson and Patrick Kulty, Baltimore, Md.		No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$75.00		$25.00		$100.00
Excavation:							
Earth ......cubic yards	2,458	$0.35	860.30	$1.00	2,458.00	$0.45	1,106.10
Hardpan ......do	3,998	.56	2,238.88	1.50	5,997.00	.75	2,998.50
Rock ......do	1,060	1.41	1,494.60	3.00	3,180.00	1.70	1,802.00
Embankment ......do	4,082	.28	1,142.96	.30	1,224.60	.26	1,061.32
Concrete:							
Natural cement ......do	5,796	4.23	24,517.06	6.20	35,935.20	5.45	31,588.20
Portland cement ......do	12,270	6.56	80,491.20	9.00	110,430.00	7.20	88,344.00
Stone filling in cribs ......do	2,882	1.06	3,054.92	2.00	5,764.00	1.60	4,611.20
Stone paving of—							
Cribs ......square yards	301	1.76	529.76	1.00	301.00	2.00	602.00
River bank ......do	891	1.76	1,568.16	1.00	891.00	1.75	1,559.25
White oak in—							
Gates ......feet B. M.	54,798	70.50	3,863.26	35.00	1,917.93	66.00	3,616.67
Quoins and sills ......do	7,950	70.50	560.48	35.00	278.25	66.00	524.70
Cribs and gate spars ......do	135,484	38.07	5,157.88	35.00	4,741.94	40.00	5,419.36
Driftbolts ......pounds	8,618	.04	344.72	.04	344.72	.02½	215.45
Total			125,899.20		173,488.64		143,548.75
Samples:							
Sand		Poor		No samples		Good.	
Stone		Excellent				Fair.	

Material.	Quantity.	No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.		No. 18.—Jas. McCarron, Philadelphia, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$50.00		$100.00		$150.00
Excavation:							
Earth ......cubic yards	2,458	$0.30	737.40	$5.75	14,133.50	$0.15	368.70
Hardpan ......do	3,998	.75	2,998.50	6.10	24,387.80	.20	799.60
Rock ......do	1,060	1.50	1,590.00	6.40	6,784.00	3.00	3,180.00
Embankment ......do	4,082	.30	1,224.60	2.60	10,613.20	.15	612.30
Concrete:							
Natural cement ......do	5,796	6.15	35,645.40	6.10	35,355.60	3.59	20,807.64
Portland cement ......do	12,270	7.90	96,933.00	8.20	100,614.00	5.74	70,429.80
Stone filling in cribs ......do	2,882	1.20	3,458.40	1.10	3,170.20	1.59	4,582.38
Stone paving of—							
Cribs ......square yards	301	2.00	602.00	1.50	451.50	3.00	903.00
River bank ......do	891	2.00	1,782.00	1.25	1,113.75	3.00	2,673.00
White oak in—							
Gates ......feet B. M.	54,798	75.00	4,109.85	57.00	3,123.49	40.00	2,191.92
Quoins and sills ......do	7,950	75.00	596.25	90.00	715.50	40.00	318.00
Cribs and gate spars ......do	135,484	35.00	4,741.94	37.00	5,012.91	35.00	4,741.94
Driftbolts ......pounds	8,618	.04	344.72	.05	430.90	.02¼	193.91
Total			154,814.06		206,006.85		111,952.19
Samples:							
Sand		Good		Fair		Poor.	
Stone		do		Excellent		Excellent.	

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[a] The Houston Construction Company, by letter dated April 26, 1897, accompanying bid, will accept 5 per cent less than sum of separate bids—

If awarded Locks and Dams 10 to 15 inclusive, i. e., $699,615.18 less 5 per cent ($34,980.76) = $664,634.42.

If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38) = $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81) = $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 12—Continued.

Material.	Quantity.	No. 20.—McArthur Brothers Co., Chicago, Ill.		No. 21.—Sweeney & Houston, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$3,000.00		$4,500.00
Excavation:					
Earth ....cubic yards..	2,458	$1.50	3,687.00	$0.65	1,597.70
Hardpan ....do....	3,998	1.50	5,997.00	2.00	7,996.00
Rock ....do....	1,060	6.00	6,360.00	2.70	2,862.00
Embankment ....do....	4,082	.40	1,632.80	.50	2,041.00
Concrete:					
Natural cement ....do....	5,796	6.50	37,674.00	6.30	36,514.80
Portland cement ....do....	12,270	8.00	98,160.00	8.90	109,203.00
Stone filling in cribs ....do....	2,882	2.40	6,916.80	2.25	6,484.50
Stone paving of—					
Cribs ....square yards..	301	1.70	511.70	2.25	677.25
River bank ....do....	891	1.40	1,247.40	2.00	1,782.00
White oak in—					
Gates ....feet B. M..	54,798	60.00	3,287.88	75.00	4,109.85
Quoins and sills ....do....	7,950	70.00	556.50	50.00	397.50
Cribs and gate spars ....do....	135,484	30.00	4,064.52	35.00	4,741.94
Driftbolts ....pounds..	8,618	.05	430.90	.04	344.72
Total			178,526.50		183,252.26
Samples:					
Sand		Excellent		No samples.	
Stone		Good			

LOCK NO. 13.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$10.00		$25.00		$1.00
Excavation:							
Earth ....cubic yards..	2,442	$0.30	732.60	$0.25	610.50	$6.00	14,652.00
Hardpan		.60		.40		6.00	
Rock ....cubic yards..	1,770	1.75	3,097.50	1.00	1,770.00	6.00	10,620.00
Embankment ....do....	5,745	.35	2,010.75	.20	1,149.00	.25	1,436.25
Concrete:							
Natural cement ....do....	4,573	5.17	23,642.41	4.90	22,407.70	7.00	32,011.00
Portland cement ....do....	9,402	7.27	68,352.54	6.70	62,993.40	9.00	84,618.00
Stone filling in cribs ....do....	2,709	1.00	2,709.00	1.50	4,063.50	1.50	4,063.50
Stone paving of—							
Cribs ....square yards..	304	1.60	486.40	1.75	532.00	1.20	364.80
River bank ....do....	3,500	.80	2,800.00	2.00	7,000.00	1.20	4,200.00
White oak in—							
Gates ....feet B. M..	52,192	55.00	2,870.56	50.00	2,609.60	50.00	2,609.60
Quoins and sills ....do....	7,386	55.00	406.23	50.00	369.30	50.00	369.30
Cribs and gate spars ....do....	126,528	24.00	3,036.67	28.00	3,542.78	30.00	3,795.84
Driftbolts ....pounds..	8,095	.03½	283.33	.02½	202.38	.02½	202.38
Total			110,437.99		107,275.16		158,943.67
Samples:							
Sand		Poor		Fair		Excellent.	
Stone		do		Good		Fair.	

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 13—Continued.

Material.	Quantity.	No. 5.—John J. Shipman, Washington, D. C.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$500.00		$200.00
Excavation:							
Earth ... cubic yards	2,442	$3.00	7,326.00	$0.80	1,953.60	$0.50	1,221.00
Hardpan		3.00		1.90		1.00	
Rock ... cubic yards	1,770	3.00	5,310.00	2.90	5,133.00	2.00	3,540.00
Embankment ... do	5,745	.50	2,872.50	.50	2,872.50	.50	2,872.50
Concrete:							
Natural cement ... do	4,573	6.00	27,438.00	7.60	34,754.80	7.40	33,840.20
Portland cement ... do	9,402	8.50	79,917.00	9.85	92,609.70	9.50	89,319.00
Stone filling in cribs ... do	2,709	1.50	4,063.50	2.00	5,418.00	2.00	5,418.00
Stone paving of—							
Cribs ... square yards	304	3.00	912.00	4.00	1,216.00	2.25	684.00
River bank ... do	3,500	1.50	5,250.00	4.00	14,000.00	2.25	7,875.00
White oak in—							
Gates ... feet B. M.	52,192	90.00	4,697.28	65.00	3,392.48	100.00	5,219.20
Quoins and sills ... do	7,386	100.00	738.60	65.00	480.09	100.00	738.60
Cribs and gate spars ... do	126,528	40.00	5,061.12	40.00	5,061.12	30.00	3,795.84
Driftbolts ... pounds	8,095	.04	323.80	.03½	283.33	.04	323.80
Total			144,009.80		167,674.62		155,047.14
Samples:							
Sand		Poor		Excellent		No samples.	
Stone		do		do			

Material.	Quantity.	No. 9.—Keeling & Ridge, Pittsburg, Pa. *a*		No. 10.—The Houston Construction Co., Philadelphia, Pa. *b*		No. 12.—Owen Patterson and Patrick Kulty, Baltimore, Md.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$50.00		$25.00
Excavation:							
Earth ... cubic yards	2,442	$0.45	1,098.90	$0.36	879.12	$1.00	2,442.00
Rock ... cubic yards	1,770	2.50	4,425.00	1.44	2,548.80	3.00	5,310.00
Embankment ... do	5,745	.75	4,308.75	.43	2,470.35	.30	1,723.50
Concrete:							
Natural cement ... do	4,573	8.00	36,584.00	4.32	19,755.36	6.50	29,724.50
Portland cement ... do	9,402	11.00	103,422.00	6.69	62,899.38	9.00	84,618.00
Stone filling in cribs ... do	2,709	2.50	6,772.50	1.08	2,925.72	2.00	5,418.00
Stone paving of—							
Cribs ... square yards	304	1.50	456.00	1.80	547.20	1.00	304.00
River bank ... do	3,500	1.50	5,250.00	1.80	6,300.00	1.00	3,500.00
White oak in—							
Gates ... feet B. M.	52,192	70.00	3,653.44	72.00	3,757.82	35.00	1,826.72
Quoins and sills ... do	7,386	60.00	443.16	72.00	531.79	35.00	258.51
Cribs and gate spars ... do	126,528	35.00	4,428.48	38.88	4,919.41	35.00	4,428.48
Driftbolts ... pounds	8,095	.04	323.80	.04	323.80	.04	323.80
Total			171,266.03		107,908.75		139,902.51
Samples:							
Sand		Poor		Poor		No samples.	
Stone		Good		Excellent			

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a Sample of stone No. 2 for concrete for Locks and Dams 10, 11, and 13, additional 25 cents per cubic yard. Sample is brown limestone, rated excellent.

b The Houston Construction Company, by letter dated April 26, 1897, accompanying bid, will accept 5 per cent less than sum of separate bids—

If awarded Locks and Dams 10 to 15 inclusive, i. e., $699,615.18 less 5 per cent ($34,980.76)= $664,634.42.

If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38)= $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81)= $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 13—Continued.

Material.	Quantity.	No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$50.00		$100.00
Excavation:							
Earth ..... cubic yards	2,442	$0.45	1,098.90	$0.30	732.60	$9.55	23,321.10
Hardpan		.75		.60		9.90	
Rock ..... cubic yards	1,770	1.70	3,009.00	1.50	2,655.00	10.30	18,231.00
Embankment ..... do	5,745	.26	1,493.70	.30	1,723.50	1.90	10,915.50
Concrete:							
Natural cement ..... do	4,573	5.50	25,151.50	6.15	28,123.95	6.60	30,181.80
Portland cement ..... do	9,402	7.25	68,164.50	7.90	74,275.80	8.70	81,797.40
Stone filling in cribs ..... do	2,709	1.60	4,334.40	1.20	3,250.80	1.10	2,979.90
Stone paving of—							
Cribs ..... square yards	304	2.00	608.00	2.00	608.00	1.50	456.00
River bank ..... do	3,500	1.75	6,125.00	2.00	7,000.00	1.25	4,375.00
White oak in—							
Gates ..... feet B. M.	52,192	66.00	3,444.67	75.00	3,914.40	57.00	2,974.94
Quoins and sills ..... do	7,386	66.00	487.48	75.00	553.95	90.00	664.74
Cribs and gate spars ..... do	126,528	40.00	5,061.12	35.00	4,428.48	37.00	4,681.54
Driftbolts ..... pounds	8,095	.02½	202.38	.04	323.80	.05	404.75
Total			119,280.65		127,640.28		181,083.67
Samples:							
Sand		Good		Good		Fair.	
Stone		Fair		Excellent		Excellent.	

Material.	Quantity.	No. 18.—Jas. McCarron, Philadelphia, Pa.		No. 20.—McArthur Brothers Co., Chicago, Ill.		No. 21.—Sweeney & Houston, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$150.00		$3,000.00		$4,500.00
Excavation:							
Earth ..... cubic yards	2,442	$0.15	366.30	$1.80	4,395.60	$0.65	1,587.30
Hardpan		.20				2.70	
Rock ..... cubic yards	1,770	3.00	5,310.00	6.00	10,620.00	2.70	4,779.00
Embankment ..... do	5,745	.15	861.75	.35	2,010.75	.50	2,872.50
Concrete:							
Natural cement ..... do	4,573	3.59	16,417.07	6.90	31,553.70	5.95	27,209.35
Portland cement ..... do	9,402	5.74	53,967.48	8.20	77,096.40	8.60	80,857.20
Stone filling in cribs ..... do	2,709	1.59	4,307.31	2.50	6,772.50	2.25	6,095.25
Stone paving of—							
Cribs ..... square yards	304	3.00	912.00	3.00	912.00	2.25	684.00
River bank ..... do	3,500	3.00	10,500.00	2.50	8,750.00	2.00	7,000.00
White oak in—							
Gates ..... feet B. M.	52,192	40.00	2,087.68	60.00	3,131.52	75.00	3,914.40
Quoins and sills ..... do	7,386	40.00	295.44	70.00	517.02	45.00	332.37
Cribs and gate spars ..... do	126,528	35.00	4,428.48	30.00	3,795.84	35.00	4,428.48
Driftbolts ..... pounds	8,095	.02¼	182.14	.05	404.75	.04	323.80
Total			99,785.65		152,960.08		144,583.65
Samples:							
Sand		Poor		Excellent		No samples.	
Stone		Excellent		Fair			

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 14.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$1.00		$25.00		$1.00
Excavation:							
Earth ... cubic yards	3,144	$0.35	1,100.40	$0.25	786.00	$5.00	15,720.00
Hardpan ... do	1,266	.70	886.20	.40	506.40	5.00	6,330.00
Rock ... do	707	1.75	1,237.25	1.00	707.00	5.00	3,535.00
Embankment ... do	3,720	.35	1,302.00	.20	744.00	.30	1,116.00
Concrete:							
Natural cement ... do	5,992	5.17	30,978.64	4.90	29,360.80	7.00	41,944.00
Portland cement ... do	9,542	7.27	69,370.34	6.70	63,931.40	9.00	85,878.00
Stone filling in cribs ... do	2,859	1.00	2,859.00	1.50	4,288.50	1.50	4,288.50
Stone paving of—							
Cribs ... square yards	304	1.60	486.40	1.75	532.00	1.00	304.00
River bank ... do	1,782	.80	1,425.60	2.00	3,564.00	1.00	1,782.00
White oak in—							
Gates ... feet B. M	52,192	55.00	2,870.56	50.00	2,609.60	50.00	2,609.60
Quoins and sills ... do	7,386	55.00	406.23	50 00	369.30	50.00	369.30
Cribs and gate spars ... do	134,028	24.00	3,216.67	28.00	3,752.78	30.00	4,020.84
Driftbolts ... pounds	8,490	.03½	297.15	.02½	212.25	.02½	212.25
Total			116,437.44		111,389.03		168,110.49
Samples:							
Sand		Poor		Fair		Excellent.	
Stone		do		Good		Fair.	

Material.	Quantity.	No. 5.—John J. Shipman, Washington, D.C.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$200.00		$500.00		$200.00
Excavation:							
Earth ... cubic yards	3,144	$3.00	9,432.00	$0.80	2,515.20	$0.50	1,572.00
Hardpan ... do	1,266	3.00	3,798.00	1.90	2,405.40	1.00	1,266.00
Rock ... do	707	3.00	2,121.00	2.90	2,050.30	2.00	1,414.00
Embankment ... do	3,720	.50	1,860.00	.50	1,860.00	.50	1,860.00
Concrete:							
Natural cement ... do	5,992	6.50	38,948.00	7.60	45,539.20	7.60	45,539.20
Portland cement ... do	9,542	8.50	81,107.00	9.85	93,988.70	9.75	93,034.50
Stone filling in cribs ... do	2,859	1.50	4,288.50	2.00	5,718.00	2.00	5,718.00
Stone paving of—							
Cribs ... square yards	304	3.00	912.00	4.00	1,216.00	2.25	684.00
River bank ... do	1,782	2.50	4,455.00	4.00	7,128.00	2.25	4,009.50
White oak in—							
Gates ... feet B. M	52,192	90.00	4,697.28	65.00	3,392.48	100.00	5,219.20
Quoins and sills ... do	7,386	100.00	738.60	65.00	480.09	100.00	738.60
Cribs and gate spars ... do	134,028	40.00	5,361.12	40.00	5,361.12	30.00	4,020.84
Driftbolts ... pounds	8,490	.04	339.60	.03½	297.15	.04	339.60
Total			158,258.10		172,451.64		165,615.44
Samples:							
Sand		Poor		Excellent		No samples.	
Stone		do		Good			

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 14—Continued.

Material.	Quantity.	No. 10.—The Houston Construction Co., Philadelphia, Pa.[a]		No. 12.—Owen Patterson and Patrick Kulty, Baltimore, Md.		No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$25.00		$100.00
Excavation:							
Earth ... cubic yards	3,144	$0.36	1,131.84	$1.00	3,144.00	$0.45	1,414.80
Hardpan ... do	1,266	.72	911.52	1.50	1,899.00	.75	949.50
Rock ... do	707	1.44	1,018.08	3.00	2,121.00	1.70	1,201.90
Embankment ... do	3,720	.29	1,078.80	.30	1,116.00	.26	967.20
Concrete:							
Natural cement ... do	5,992	4.32	25,885.44	6.00	35,952.00	5.50	32,956.00
Portland cement ... do	9,542	6.69	63,835.98	9.00	85,878.00	7.25	69,179.50
Stone filling in cribs ... do	2,859	1.08	3,087.72	2.00	5,718.00	1.60	4,574.40
Stone paving of—							
Cribs ... square yards	304	1.80	547.20	1.00	304.00	2.00	608.00
River bank ... do	1,782	1.80	3,207.60	1.00	1,782.00	1.75	3,118.50
White oak in—							
Gates ... feet B. M.	52,192	72.00	3,757.82	35.00	1,826.72	66.00	3,444.67
Quoins and sills ... do	7,386	72.00	531.79	35.00	258.51	66.00	487.48
Cribs and gate spars ... do	134,028	38.88	5,211.01	35.00	4,690.98	40.00	5,361.12
Driftbolts ... pounds	8,490	.04	339.60	.04	339.60	.02¼	212.25
Total			110,644.40		145,054.81		124,575.32
Samples:							
Sand		Poor		No samples		Good.	
Stone		Excellent				Fair.	

Material.	Quantity.	No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$50.00		$100.00
Excavation:					
Earth ... cubic yards	3,144	$0.35	1,100.40	$8.25	25,938.00
Hardpan ... do	1,266	.75	949.50	8.60	10,887.60
Rock ... do	707	2.00	1,414.00	9.00	6,363.00
Embankment ... do	3,720	.35	1,302.00	2.80	10,416.00
Concrete:					
Natural cement ... do	5,992	6.15	36,850.80	6.55	39,247.60
Portland cement ... do	9,542	7.90	75,381.80	8.70	83,015.40
Stone filling in cribs ... do	2,859	1.20	3,430.80	1.10	3,144.90
Stone paving of—					
Cribs ... square yards	304	2.00	608.00	1.50	456.00
River bank ... do	1,782	2.00	3,564.00	1.25	2,227.50
White oak in—					
Gates ... feet B. M.	52,192	75.00	3,914.40	57.00	2,974.94
Quoins and sills ... do	7,386	75.00	553.95	90.00	664.74
Cribs and gate spars ... do	134,028	35.00	4,690.98	37.00	4,959.04
Driftbolts ... pounds	8,490	.04	339.60	.05	424.50
Total			134,150.23		190,819.22
Samples:					
Sand		Good		Fair.	
Stone		Fair		Excellent.	

[a] The Houston Construction Company, by letter dated April 26, 1897, accompanying bid, will accept 5 per cent less than sum of separate bids—

If awarded Locks and Dams 10 to 15 inclusive, i. e., $699,615.18 less 5 per cent ($34,980.76) = $664,634.42.

If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38) = $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823 81) = $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 14—Continued.

Material.	Quantity.	No. 18.—Jas. McCarron, Philadelphia, Pa.		No. 20.—McArthur Brothers Co., Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$150.00		$3,000.00
Excavation:					
Earth ....cubic yards	3,144	$0.15	471.60	$1.80	5,659.20
Hardpan ....do	1,266	.20	253.20	1.80	2,278.80
Rock ....do	707	3.00	2,121.00	6.00	4,242.00
Embankment ....do	3,720	.15	558.00	.60	2,232.00
Concrete:					
Natural cement ....do	5,992	3.59	21,511.28	7.00	41,944.00
Portland cement ....do	9,542	5.74	54,771.08	8.30	79,198.60
Stone filling in cribs ....do	2,859	1.59	4,545.81	2.50	7,147.50
Stone paving of—					
Cribs ....square yards	304	3.00	912.00	3.00	912.00
River bank ....do	1,782	3.00	5,346.00	2.50	4,455.00
White oak in—					
Gates ....feet B. M.	52,192	40.00	2,087.68	60.00	3,131.52
Quoins and sills ....do	7,386	40.00	295.44	70.00	517.02
Cribs and gate spars ....do	134,028	35.00	4,690.98	30.00	4,020.84
Driftbolts ....pounds	8,490	.02½	191.03	.05	424.50
Total			97,905.10		159,162.98
Samples:					
Sand		Poor		Excellent.	
Stone		Excellent		Good.	

LOCK NO. 15.

Material.	Quantity.	No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 3.—McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.		No. 4.—I. V. Hoag, jr., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$50.00		$25.00		$1,000.00
Excavation:							
Earth ....cubic yards	8,717	$0.30	2,615.10	$0.25	2,179.25	$3.25	28,330.25
Hardpan		.70		.40		3.25	
Rock ....cubic yards	845	1.75	1,478.75	1.00	845.00	3.25	2,746.25
Embankment ....do	6,010	.35	2,103.50	.20	1,202.00	.30	1,203.00
Concrete:							
Natural cement ....do	4,595	5.17	23,756.15	4.90	22,515.50	7.00	32,165.00
Portland cement ....do	9,378	7.27	68,178.06	6.70	62,832.60	9.00	84,402.00
Stone filling in cribs ....do	2,820	1.00	2,820.00	1.50	4,230.00	1.50	4,230.00
Stone paving of—							
Cribs ....square yards	234	1.60	374.40	1.75	409.50	1.00	234.00
River bank ....do	3,433	.80	2,746.40	2.00	6,866.00	1.00	3,433.00
White oak in—							
Gates ....feet B. M.	52,192	55.00	2,870.56	50.00	2,609.60	50.00	2,609.60
Quoins and sills ....do	7,386	55.00	406.23	50.00	369.30	50.00	369.30
Cribs and gate spars ....do	131,160	24.00	3,147.84	28.00	3,672.48	30.00	3,934.80
Driftbolts ....pounds	8,172	.03½	286.02	.02½	204.30	.02½	204.30
Total			110,833.01		107,960.53		165,461.50
Samples:							
Sand		Poor		Good		Excellent.	
Stone		do		Fair		Fair.	

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 15—Continued.

Material.	Quantity.	No. 5.—John J. Shipman, Washington, D.C.		No. 7.—Jutte & Foley Co., Pittsburg, Pa.		No. 8.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing	....	......	$2,000.00	......	$3,000.00	......	$200.00
Excavation:							
Earth .... cubic yards..	8,717	$3.00	26,151.00	$0.80	6,973.60	$0.50	4,358.50
Hardpan	....	3.00	....	1.90	....	1.00	....
Rock .... cubic yards..	845	3.00	2,535.00	2.90	2,450.50	2.00	1,690.00
Embankment .... do....	6,010	.50	3,005.00	.50	3,005.00	.50	3,005.00
Concrete:							
Natural cement .... do....	4,595	5.00	22,975.00	7.80	35,841.00	7.60	34,922.00
Portland cement .... do....	9,378	8.00	75,024.00	10.05	94,248.90	9.75	91,435.50
Stone filling in cribs .... do....	2,820	1.50	4,230.00	2.00	5,640.00	2.00	5,640.00
Stone paving of—							
Cribs .... square yards..	234	3.00	702.00	4.00	936.00	2.25	526.50
River bank .... do....	3,433	1.00	3,433.00	4.00	13,732.00	2.25	7,724.25
White oak in—							
Gates .... feet B. M..	52,192	90.00	4,697.28	65.00	3,392.48	100.00	5,219.20
Quoins and sills .... do....	7,386	100.00	738.60	65.00	480.09	100.00	738.60
Cribs and gate spars .... do....	131,160	40.00	5,246.40	40.00	5,246.40	30.00	3,934.80
Driftbolts .... pounds..	8,172	.04	326.88	.03½	286.02	.04	326.88
Total	....	......	151,064.16	......	175,231.99	......	159,721.23
Samples:							
Sand	....	Poor		Excellent		No samples.	
Stone	....	Excellent		Good			

Material.	Quantity.	No. 10.—The Houston Construction Co., Philadelphia, Pa.[a]		No. 12.—Owen Patterson and Patrick Kulty, Baltimore, Md.		No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing	....	......	$100.00	......	$25.00	......	$100.00
Excavation:							
Earth .... cubic yards..	8,717	$0.36	3,138.12	$1.00	8,717.00	$0.45	3,922.65
Hardpan	....	......	....	......	....	.75	....
Rock .... cubic yards..	845	1.45	1,225.25	3.00	2,535.00	1.70	1,436.50
Embankment .... do....	6,010	.29	1,742.90	.30	1,803.00	.26	1,562.60
Concrete:							
Natural cement .... do....	4,595	4.35	19,988.25	6.00	27,570.00	5.50	25,272.50
Portland cement .... do....	9,378	6.74	63,207.72	9.25	86,746.50	7.25	67,990.50
Stone filling in cribs .... do....	2,820	1.08	3,045.60	2.00	5,640.00	1.60	4,512.00
Stone paving of—							
Cribs .... square yards..	234	1.81	423.54	1.00	234.00	2.00	468.00
Riverbank .... do....	3,433	1.81	6,213.73	1.00	3,433.00	1.75	6,007.75
White oak in—							
Gates .... feet B. M..	52,192	72.50	3,783.92	35.00	1,826.72	66.00	3,444.67
Quoins and sills .... do....	7,386	72.50	535.49	35.00	258.51	66.00	487.48
Cribs and gate spars .... do....	131,160	39.15	5,134.91	35.00	4,590.60	40.00	5,246.40
Driftbolts .... pounds..	8,172	.04½	367.74	.04	326.88	.02½	204.30
Total	....	......	108,907.17	......	143,706.21	......	120,655.35
Samples:							
Sand	....	Poor		No samples....		Good.	
Stone	....	Excellent				Fair.	

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If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38) = $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81) = $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

LOCK NO. 15—Continued.

Material.	Quantity.	No. 14.—Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.		No. 15.—The Barnett & Record Co., Minneapolis, Minn.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$50.00		$100.00
Excavation:					
Earth ..... cubic yards	8,717	$0.30	2,615.10	$4.60	40,098.20
Hardpan		.60		6.00	
Rock ..... cubic yards	845	2.50	2,112.50	6.35	5,365.75
Embankment ..... do	6,010	.35	2,103.50	1.90	1,141.90
Concrete:					
Natural cement ..... do	4,595	6.40	29,408.00	6.60	30,327.00
Portland cement ..... do	9,378	8.20	76,899.60	8.70	81,588.60
Stone filling in cribs ..... do	2,820	1.50	4,230.00	1.10	3,102.00
Stone paving of—					
Cribs ..... square yards	234	2.25	526.50	1.50	351.00
River bank ..... do	3,433	2.25	7,724.25	1.25	4,291.25
White oak in—					
Gates ..... feet B. M	52,192	75.00	3,914.40	57.00	2,974.94
Quoins and sills ..... do	7,386	75.00	553.95	90.00	664.74
Cribs and gate spars ..... do	131,160	35.00	4,590.60	37.00	4,852.92
Driftbolts ..... pounds	8,172	.04	326.88	.05	408.60
Total			135,055.28		175,266.90
Samples:					
Sand		Good		Fair.	
Stone		Fair		Excellent.	

Material.	Quantity.	No. 18.—Jas. McCarron, Philadelphia, Pa.		No. 20.—McArthur Brothers Co., Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$150.00		$3,000.00
Excavation:					
Earth ..... cubic yards	8,717	$0.15	1,307.55	$1.50	13,075.50
Hardpan		.20			
Rock ..... cubic yards	845	3.00	2,535.00	6.00	5,070.00
Embankment ..... do	6,010	.15	901.50	.50	3,005.00
Concrete:					
Natural cement ..... do	4,595	3.59	16,496.05	6.70	30,786.50
Portland cement ..... do	9,378	5.74	53,829.72	8.20	76,899.60
Stone filling in cribs ..... do	2,820	1.59	4,483.80	2.50	7,050.00
Stone paving of—					
Cribs ..... square yards	234	3.00	702.00	3.00	702.00
River bank ..... do	3,433	3.00	10,299.00	2.50	8,582.50
White oak in—					
Gates ..... feet B. M	52,192	40.00	2,087.68	60.00	3,131.52
Quoins and sills ..... do	7,386	40.00	295.44	70.00	517.02
Cribs and gate spars ..... do	131,160	35.00	4,590.60	30.00	3,934.80
Driftbolts ..... pounds	8,172	.02¼	183.87	.05	408.60
Total			97,862.21		156,163.04
Samples:					
Sand		Poor		Excellent.	
Stone		Excellent		Good.	

LOCKS AND DAMS NOS. 10 TO 15, ONE PROPOSAL.

Material.	Quantity.	No. 1.—Heldmaier & Neu, Chicago, Ill.		No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 11.—Michael J. Fenton, New York, N. Y.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Grubbing and clearing			$100.00		$10.00		
Excavation:							
Earth ..... cubic yards	29,971	$0.48	14,386.08	$0.30	8,991.30	$0.75	$22,478.25
Hardpan ..... do	5,264	.90	4,737.60	.70	3,684.80	1.00	5,264.00
Rock ..... do	8,100	1.10	8,910.00	1.75	14,175.00	5.00	40,500.00
Embankment ..... do	26,161	.30	7,848.30	.35	9,156.35	.30	7,848.30
Concrete:							
Natural cement ..... do	32,360	3.95	127,822.00	5.10	165,036.00	4.50	145,620.00
Portland cement ..... do	62,424	6.70	418,240.80	7.20	449,452.80	7.50	468,180.00
Stone filling in cribs ..... do	16,751	.90	15,075.90	.97	16,248.47	2.25	37,689.75

Abstract of proposals for constructing Locks and Dams Nos. 10 to 15, inclusive.—Cont'd.

LOCKS AND DAMS NOS. 10 TO 15, ONE PROPOSAL—Continued.

Material.	Quantity.	No. 1.—Heldmaier & Neu, Chicago, Ill.		No. 2.—C. I. & A. W. McDonald, Pittsburg, Pa.		No. 11.—Michael J. Fenton, New York, N. Y.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
Stone paving of—							
Cribs……………square yards..	1,678	2.95	$4,950.10	1.50	$2,517.00	1.00	$1,678.00
River bank ……………do….	13,012	2.35	30,578.20	.80	10,409.60	.80	10,409.60
White oak in—							
Gates ……………feet B. M..	318,364	34.50	10,983.56	55.00	17,510.02	60.00	19,101.84
Quoins and sills……………do….	45,444	42.50	1,931.37	55.00	2,499.42	120.00	5,453.28
Cribs and gate spars……………do….	761,640	24.00	18,279.36	24.00	18,279.36	35.00	26,657.40
Driftbolts……………pounds..	49,358	.03	1,480.74	.03½	1,727.53	.03	1,480.74
Total……………	………	………	665,324.01	………	719,697.65	………	792,861.16
Samples:							
Sand ……………	………	Poor ……………		Poor ……………		No samples.	
Stone……………	………	Good ……………		……do……………			

Material.	Quantity.	No. 13.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 16.—B. J. Coyle, Washington, D.C.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing ……………	………	………	$100.00	………	$450.00
Excavation:					
Earth ……………cubic yards..	29,971	$0.45	13,486.95	$1.20	35,965.20
Hardpan ……………do….	5,264	.75	3,948.00	2.00	10,528.00
Rock……………do….	8,100	1.70	13,770.00	3.20	25,920.00
Embankment……………do….	26,161	.26	6,801.86	.40	10,464.40
Concrete:					
Natural cement……………do….	32,360	5.25	169,890.00	7.90	255,644.00
Portland cement……………do….	62,424	7.00	436,968.00	9.40	586,785.60
Stone filling in cribs……………do….	16,751	1.60	26,801.60	1.50	25,126.50
Stone paving of—					
Cribs ……………square yards..	1,678	2.00	3,356.00	1.25	2,097.50
River bank ……………do….	13,012	1.75	22,771.00	2.00	26,024.00
White oak in—					
Gates ……………feet B. M..	318,364	66.00	21,012.02	50.00	15,918.20
Quoins and sills……………do….	45,444	66.00	2,999.30	50.00	2,272.20
Cribs and gate spars……………do….	761,640	40.00	30,465.60	30.00	22,849.20
Driftbolts……………pounds..	49,358	.02½	1,233.95	.05	2,467.90
Total……………	………	………	753,604.28	………	1,022,512.70
Samples:					
Sand ……………	………	Good ……………		Good.	
Stone……………	………	Fair……………		Fair.	

Material.	Quantity.	No. 17.—Truax & Sheridan, Buffalo, W. Va.		No. 19.—J. W. Hoffman & Co., Philadelphia, Pa.	
		Rate.	Amount.	Rate.	Amount.
Grubbing and clearing ……………	………	………	$1,800.00	………	$3,000.00
Excavation:					
Earth ……………cubic yards..	29,971	$0.75	22,478.25	$0.60	17,982.60
Hardpan……………do….	5,264	1.35	7,106.40	1.50	7,896.00
Rock ……………do….	8,100	2.00	16,200.00	2.00	16,200.00
Embankment……………do….	26,161	.40	10,464.40	1.00	26,161.00
Concrete:					
Natural cement……………do….	32,360	6.00	194,160.00	4.80	155,328.00
Portland cement……………do….	62,424	7.65	477,543.60	6.44	402,010.56
Stone filling in cribs……………do….	16,751	1.50	25,126.50	2.50	41,877.50
Stone paving of—					
Cribs……………square yards..	1,678	2.00	3,356.00	3.00	5,034.00
River bank ……………do….	13,012	2.00	26,024.00	3.00	39,036.00
White oak in—					
Gates … ……………feet B. M..	318,364	75.00	23,877.30	52.00	16,554.93
Quoins and sills……………do….	45,444	75.00	3,408.30	60.00	2,727.64
Cribs and gate spars……………do….	761,640	40.00	30,465.60	47.00	35,797.08
Driftbolts……………pounds..	49,358	.03	1,480.74	.01½	740.37
Total……………	………	………	843,491.09	………	770,344.68
Samples:					
Sand ……………	………	Good……………		Fair.	
Stone……………	………	Fair……………		Good.	

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

SUMMARY OF ITEMIZED ABSTRACT.

No.	Name and address of bidder.	No. 10.			No. 11.		
		Amount.	Samples.		Amount.	Samples.	
			Sand.	Stone.		Sand.	Stone.
1	Heldmaier & Neu, Chicago, Ill.	....	....	....	....	....	
2	C. I. & A. W. McDonald, Pittsburg, Pa.	$113,152.95	Poor......	Poor......	$145,468.88	Poor......	Poor.
3	McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.	105,503.43	Good	Good	134,091.82	Good	Fair.
4	I. V. Hoag, jr., Pittsburg, Pa.	177,157.50	Excellent.	Fair	200,213.98	Excellent.	Do.
5	John J. Shipman, Washington, D. C.	....	....	....	194,079.74	Poor......	Poor.
6	Hulings Bros., Pittsburg, Pa.	138,987.57	Fair	Fair	....	....	
7	Jutte & Foley Co., Pittsburg, Pa.	167,283.62	Excellent.	Good	211,845.58	Excellent.	Fair.
8	Jacob Friday & Sons, Pittsburg, Pa.	150,352.45	No sample	No sample	191,749.92	No sample	No sample.
9	Keeling & Ridge, Pittsburg, Pa.[a]	165,425.30	Poor......	Good	193,970.88	Poor......	Good.
10	The Houston Construction Co., Philadelphia, Pa.[b]	116,379.18	.....do	Excellent.	129,876.48	.....do	Excellent.
11	Michael J. Fenton, New York, N. Y.	....	....	....	....	....	
12	Owen Patterson & Patrick Kulty, Baltimore, Md.	145,232.43	No sample	No sample	178,768.90	No sample	No sample.
13	The T. A. Gillespie Co., Pittsburg, Pa.	120,734.60	Good	Fair	149,446.54	Good	Fair.
14	Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.	140,696.89	.....do	.....do	160,864.12	.....do	Do.
15	The Barnett & Record Co., Minneapolis, Minn.	187,507.85	Fair	Excellent.	217,805.90	Fair	Excellent.
16	B. J. Coyle, Washington, D. C.	....	....	....	....	....	
17	Truax & Sheridan, Buffalo, W. Va.	....	....	....	....	....	
18	James McCarron, Philadelphia, Pa.	95,059.35	Poor......	Excellent.	119,618.64	Poor......	Do.
19	J. W. Hoffman & Co., Philadelphia, Pa.	....	....	....	....	....	
20	McArthur Brothers Co., Chicago, Ill.	154,341.94	Excellent.	Excellent.	184,728.03	Excellent.	Do.
21	Sweeney & Houston, Pittsburg, Pa.	....	....	....	....	....	

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[a] Sample of stone No. 2 for concrete for Locks and Dams 10, 11, and 13, additional 25 cents per cubic yard. Sample is brown limestone, rated excellent.

[b] The Houston Construction Company, by letter dated April 26, 1897, accompanying bid, will accept 5 per cent less than sum of separate bids—

If awarded Locks and Dams 10 to 15 inclusive, i. e., $699,615.18 less 5 per cent ($34,980.76) = $664,634.42.

If awarded Locks and Dams 12 to 15 inclusive, i. e., $453,359.52 less 4 per cent ($18,134.38) = $435,225.14.

If awarded Locks and Dams 13 to 15 inclusive, i. e., $327,460.32 less 3 per cent ($9,823.81) = $317,636.51.

NOTE.—Samples rated according to quality, as "poor," "fair," "good," or "excellent," for comparison.

Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

SUMMARY OF ITEMIZED ABSTRACT—Continued.

No.	Name and address of bidder.	No. 12.			No. 13.		
		Amount.	Samples.		Amount.	Samples.	
			Sand.	Stone.		Sand.	Stone.
1	Heldmaier & Neu, Chicago, Ill.	....	....	....	....	....	
2	C. I. & A. W. McDonald, Pittsburg, Pa.	$136, 678. 91	Poor	Poor	$110, 437. 99	Poor	Poor.
3	McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.	128, 502. 65	Good	Fair	107, 275. 16	Fair	Good.
4	I. V. Hoag, jr., Pittsburg, Pa.	191, 500. 27	Excellent	do	158, 943. 67	Excellent	Fair.
5	John J. Shipman, Washington, D. C.	185, 702. 40	Poor	Poor	144, 009. 80	Poor	Poor.
6	Hulings Bros., Pittsburg, Pa.	....	....	....	....	....	
7	Jutte & Foley Co., Pittsburg, Pa.	184, 158. 91	Excellent	Excellent	167, 674. 62	Excellent	Excellent.
8	Jacob Friday & Sons, Pittsburg, Pa.	188, 173. 44	No sample	No sample	155, 047. 14	No sample	No sample.
9	Keeling & Ridge, Pittsburg, Pa. [a]	....	....	....	171, 266. 03	Poor	Good.
10	The Houston Construction Co., Philadelphia, Pa. [b]	125, 899. 20	Poor	Excellent	107, 908. 75	do	Excellent.
11	Michael J. Fenton, New York, N. Y.	....	....	....	....	....	
12	Owen Patterson & Patrick Kulty, Baltimore, Md.	173, 488. 64	No sample	No sample	139, 902. 51	No sample	No sample.
13	The T. A. Gillespie Co., Pittsburg, Pa.	143, 548. 75	Good	Fair	119, 280. 65	Good	Fair.
14	Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.	154, 814. 06	do	Good	127, 640. 28	do	Excellent.
15	The Barnett & Record Co., Minneapolis, Minn.	206, 006. 35	Fair	Excellent	181, 083. 67	Fair	Do.
16	B. J. Coyle, Washington, D. C.	....	....	....	....	....	
17	Truax & Sheridan, Buffalo, W. Va.	....	....	....	....	....	
18	James McCarron, Philadelphia, Pa.	111, 952. 19	Poor	Excellent	99, 785. 65	Poor	Do.
19	J. W. Hoffman & Co., Philadelphia, Pa.	....	....	....	....	....	
20	McArthur Brothers Co., Chicago, Ill.	173, 526. 50	Excellent	Good	152, 960. 08	Excellent	Fair.
21	Sweeney & Houston, Pittsburg, Pa.	183, 252. 26	No sample	No sample	144, 583. 65	No sample	No sample.

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

SUMMARY OF ITEMIZED ABSTRACT—Continued.

No.	Name and address of bidder.	No. 14.			No. 15.		
		Amount.	Samples.		Amount.	Samples.	
			Sand.	Stone.		Sand.	Stone.
1	Heldmaier & Neu, Chicago, Ill.	....	....	....	....	....	
2	C. I. & A. W. McDonald, Pittsburg, Pa.	$110,437.44	Poor	Poor	$110,833.01	Poor	Poor.
3	McLean, Kaufman & Co., Pittsburg, Pa., and New York, N.Y.	111,389.03	Fair	Good	107,960.53	Good	Fair.
4	I. V. Hoag, jr., Pittsburg, Pa.	168,110.49	Excellent.	Fair	165,461.50	Excellent.	Do.
5	John J. Shipman, Washington, D. C.	158,258.10	Poor	Poor	151,064.16	Poor	Excellent.
6	Hulings Bros., Pittsburg, Pa.	....	....	....	....	....	
7	Jutte & Foley Co., Pittsburg, Pa.	172,451.64	Excellent.	Good	175,281.99	Excellent.	Good.
8	Jacob Friday & Sons, Pittsburg, Pa.	165,615.44	Nosample	Nosample	159,721.23	Nosample	Nosample.
9	Keeling & Ridge, Pittsburg, Pa.[a]	....	....	....	....	....	
10	The Houston Construction Co., Philadelphia, Pa.[b]	110,644.40	Poor	Excellent.	108,907.17	Poor	Excellent.
11	Michael J. Fenton, New York, N. Y.	....	....	....	....	....	
12	Owen Patterson & Patrick Kulty, Baltimore, Md.	145,054.81	Nosample	Nosample	143,706.21	Nosample	Nosample.
13	The T. A. Gillespie Co., Pittsburg, Pa.	124,575.32	Good	Fair	120,655.35	Good	Fair.
14	Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.	134,150.23	.....do	.....do	135,055.28	.....do	Do.
15	The Barnett & Record Co., Minneapolis, Minn.	190,819.22	Fair	Excellent.	175,266.90	Fair	Excellent.
16	B. J. Coyle, Washington, D. C.	....	....	....	....	....	
17	Truax & Sheridan, Buffalo, W. Va.	....	....	....	....	....	
18	James McCarron, Philadelphia, Pa.	97,905.10	Poor	Excellent.	97,862.21	Poor	Do.
19	J. W. Hoffman & Co., Philadelphia, Pa.	....	....	....	....	....	
20	McArthur Brothers Co., Chicago, Ill.	159,162.98	Excellent.	Good	156,163.04	Excellent.	Good.
21	Sweeney & Houston, Pittsburg, Pa.	....	....	....	....	....	

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Abstract of proposals for building Locks and Dams Nos. 10 to 15, inclusive, etc.—Cont'd.

SUMMARY OF ITEMIZED ABSTRACT—Continued.

No.	Name and address of bidder.	Nos. 10 to 15, one proposal.		
		Amount.	Samples.	
			Sand.	Stone.
1	Heldmaier & Neu, Chicago, Ill	$665, 324. 01	Poor	Good.
2	C. I. & A. W. McDonald, Pittsburg, Pa	719, 697. 65	do	Poor.
3	McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y.			
4	I. V. Hoag, jr., Pittsburg, Pa			
5	John J. Shipman, Washington, D. C			
6	Hulings Bros., Pittsburg, Pa			
7	Jutte & Foley Co., Pittsburg, Pa			
8	Jacob Friday & Sons, Pittsburg, Pa			
9	Keeling & Ridge, Pittsburg, Pa. *a*			
10	The Houston Construction Co., Philadelphia, Pa. *b*	664, 634. 42	Poor	Excellent.
11	Michael J. Fenton, New York, N. Y	792, 361. 16	No sample	No sample.
12	Owen Patterson & Patrick Kulty, Baltimore, Md			
13	The T. A. Gillespie Co., Pittsburg, Pa	753, 604. 28	Good	Fair.
14	Sturm & Cramer, Belpre, Ohio, and Parkersburg, W. Va.			
15	The Barnett & Record Co., Minneapolis, Minn			
16	B. J. Coyle, Washington, D. C	1, 022, 512. 70	Good	Do.
17	Truax & Sheridan, Buffalo, W. Va	843, 491. 09	do	Do.
18	James McCarron, Philadelphia, Pa			
19	J. W. Hoffman & Co., Philadelphia, Pa	770, 344. 68	Fair	Good.
20	McArthur Brothers Co., Chicago, Ill			
21	Sweeney & Houston, Pittsburg, Pa			

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COMMERCIAL STATISTICS.

A daily line of packets runs from Pittsburg to Morgantown; a towboat and a steam tug work for a sawmill in Pool 8 or do jobbing, generally in pools 8 and 9.

Comparative statement of commerce that passed through United States Locks Nos. 8 and 9 for the past five years.

Year.	Lock No. 8.		Lock No. 9.	
	Passengers.	Freight.	Passengers.	Freight.
	Number.	*Tons.*	*Number.*	*Tons.*
1892	18, 663	20, 769. 69	17, 932	20, 644. 45
1893	24, 534	17, 587. 11	23, 932	19, 426. 83
1894	18, 610	24, 328. 55	16, 968	17, 134. 10
1895	15, 107	19, 825. 99	11, 459	10, 758. 62
1896	11, 006	31, 722. 22	11, 296	13, 734. 95

NOTE.—The freight comprised merchandise and lumber and timber in rafts.

The following table, compiled from the annual reports of the Monongahela Navigation Company, shows the commercial movement on the lower part of this river for the past eight years:

Articles.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Brick	6,333	7,856	7,897	8,181	6,344	1,874	118	2,277
Cattle and horses	729	648	783	647	611	456	422	380
Classified freight	18,334	23,169	21,746	21,891	20,076	27,387	26,918	28,395
Coal and coke	3,084,175	4,486,322	4,291,874	3,884,162	3,865,592	4,655,408	4,189,220	5,713,594
Fire clay	5,982	5,021	6,193	4,720	220	70	....	....
Hogs	266	340	302	107	81	122	55	91
Iron:								
Ore	3,871	2,335	....	....	....	....	....	....
In pigs	15	5	3	....	....	....	....	....
Lumber	10,095	11,615	25,887	23,738	22,331	24,863	22,544	21,043
Pipe	....	2,394	....	....	....	....	....	....
Posts	700	1,069	4,910	....	2,256	1,140	1,827	2,009
Posts, pit	18,707	29,336	9,786	14,952	4,194	4,875	28,545	6,861
Railroad ties	3,165	232	160	....	....	....	730	9,611
Sand	73,590	105,600	74,600	89,900	113,400	94,950	76,800	79,300
Sheep	164	60	112	123	207	231	255	142
Staves	26	140	109	98	178	246	75	152
Steel rails	32,177	84,609	11,422	29,891	19,866	89,342	34,797	57,397
Stone	9 580	811	4,595	2,120	5,647	2,685	6,078	910
Timber	54,696	43,970	67,164	81,759	80,000	62,627	66,556	66,037
Whisky	134	180	922	1,515	1,641	2,813	763	810
Wood	....	58	....	....	....	....	....	150
Total	3,322,239	4,755,790	4,528,465	4,163,304	4,142,644	4,918,089	4,455,703	5,989,159
Passengers	45,811	31,828	48,744	80,590	98,440	81,550	77,050	54,838

Classes of boats that come to Pittsburg Harbor or ply on the Allegheny or the Monongahela rivers.

Class.	Number.	Tonnage.		Draft of water.
		Gross.	Net.	
Merchant steam vessels:				*Feet.*
Towboats	86	22,101.89	20,563.62	3 to 8
Passenger and freight boats	34	7,156.73	5,473.05	1.5 to 6.5
Dredge boats	12	1,306.89	1,033.81	3 to 4.5
Pump boats	3	22.58	22.58	2.6 to 3
Ferryboats	8	415.18	405.87	2.5 to 5.4
Pleasure steamers	19	140.81	135.77	2.5 to 4.6
Pleasure yachts	4	20.00	20.00	2.5 to 4
Launch (naphtha)	1	1.75	1.75	2.6
Unrigged merchant vessels: Decked barges	74	45,611.34	45,611.34	3 to 8
Craft not enrolled:				
Coal boats	945	993,970.00	993,970.00	6 to 8
Coal barges	1,580	825,925.00	825,925.00	6 to 7
Fuel barges	102	28,886.00	28,886.00	6 to 7
Flats—				
Coal	853	155,917.00	155,917.00	3 to 7
Sand	220	22,000.00	22,000.00	3 to 4
Skeleton barges	10	6,000.00	6,000.00	6 to 7
Total	....	2,109,475.12	2,105,965.29	....

Bench marks, leveling of 1896, by Assistant Engineer Philip Golay, pool No. 9 to Hoults.

[Assumed datum is mean tidal level at Sandy Hook, N. J., obtained by means of railroad levels connected with principal bench of Pennsylvania Railroad at Uniontown, Pa.]

Elevation.	Bench.
787.000	Upper miter sill, lock No. 9.
820.601	Eye of ring bolt, north end of Morgantown Suspension Bridge abutment, right bank.
821.867	North corner, north abutment, railroad bridge, Deckers Creek. B. M., cut.
804.695	Railroad spike in Sycamore, left bank, about 1,200 feet above the Morgantown Suspension Bridge.
822.130	North corner, north abutment, railroad bridge, Coburns Creek. B. M., cut.
816.249	North end of doorsill, boiler house of pump station, Eureka Pipe Line Co.
813.152	Railroad spike in walnut, right bank, lock No. 11.
830.575	Spike in locust, left bank, lock No. 11.
828.852	North corner, northeast abutment, railroad bridge, Booths Creek. B. M., cut.
843.139	Railroad spike in beech above railroad near railroad culvert, lower end of Round Bottom.
834.606	Railroad spike in walnut, near residence of J. D. Summers, right bank.
838.201	Railroad spike in oak, near residence of J. D. Summers, right bank.
839.365	Railroad spike in locust, right bank, about 700 feet above dam No. 12.
821.455	Spike in hickory, left bank, lock No. 12.
849.258	Railroad spike in chestnut, left bank, near line of axis of dam No. 12.
849.845	Railroad spike in chestnut, left bank, about 180 feet above line of axis of dam No. 12.
852.051	Railroad spike in locust in bottom, left side of river, lock No. 12.
846.129	North corner, northeast abutment, railroad bridge, Toms Run. B. M., cut.
851.417	Northeast corner, east abutment, railroad bridge, Joes Run. B. M., cut.
857.352	Point on rock ledge above railroad, right bank, upper end of railroad rock cut just below dam No. 13. B. M., cut.
832.143	Railroad spike in oak, left bank, lock No. 13.
846.308	Railroad spike in apple tree, left side of river, lock No. 13.
848.470	Railroad spike in chestnut, right bank, Trippetts Ripple.
859.152	Railroad spike in locust, right bank, near brick house below Big Falls.
835.875	Railroad spike in sycamore, right shore, lock No. 14.
837.780	Point on flat rock, left shore, lock No. 14. B. M., cut.
858.827	Spike in apple tree in John Hood's orchard, lock No. 14, left side of river.
863.515	North corner, northeast abutment, railroad bridge, White Day Creek. B. M., cut.
875.741	Railroad spike in locust near residence of A. B. Jolliff, right side of river.
868.385	North corner, northeast abutment, railroad bridge, Little Creek. B. M., cut.
879.747	Railroad spike in walnut, upper end railroad cut above Catawba Station.
873.567	East corner, southeast abutment, railroad bridge, Pricketts Creek. B. M., cut.
875.665	Southwest corner of stone foundation of brick warehouse, Montana.
879.279	Railroad spike in gum, right bank, Rivesville Station.
861.206	Railroad spike in hickory, right bank, near residence of Ira Fleming, deceased, lower site for lock No. 15.
851.277	Railroad spike in sycamore, left bank, mouth of Hockinberry Hollow.
862.433	Railroad spike in sugar tree, right bank. above railroad, near vacant house.
856.516	Railroad spike in oak, right bank, Pitchers Ripple.
866.940	Railroad spike in sugar tree, left bank, Pitchers Ripple.
859.589	Railroad spike in sycamore, right bank, Hoult's mill, upper site for lock No. 15.
859.153	Railroad spike in swamp oak, left bank, opposite Hoult's mill, upper site for lock No. 15.

Bridges completed over Monongahela River and its branches not previously reported.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low-water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
Suterville	30	Iron truss; highway.	3	320	33 to 37	Youghiogheny River.
Bellevernon	43.5	do	3	350	54	Pool No. 4, Monongahela River.

NOTE.—Records do not show that the plans of the Bellevernon Bridge were approved by the Secretary of War.

Bridges authorized and under construction at end of year.

Name.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low-water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
South Twenty-second Street, Pittsburg.	2.3	Iron truss; highway	3	500	53	No. 1, Monongahela River.
Rankin	9	do	3	500	55	Do.
Port Perry	11.7	Iron truss; railroad	6	378.5	66	Do.

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
South Twenty-second Street, Pittsburg.	May 7, 1894	Aug. 21, 1894	1 year from date of act	3 years thereafter.
Rankin	Apr. 21, 1894	July 20, 1896; modified Dec. 21, 1896.	do	Do.
Port Perry	Jan. 26, 1897	Mar. 8, 1897	do	Do.

NOTE.—The South Twenty-second Street Bridge, Pittsburg, is completed, except that mooring rings for the use of navigators, have not been inserted in the channel piers.

Bridges authorized, but whose construction had not been commenced at end of year.

Name.	Distance above mouth.	Kind.	Number of spans.	Channel span.		Name of pool or branch in which located.
				Clear width on low-water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
Ferry Street, Pittsburg.	0.5	Iron truss; railway and highway.	3	750	80	Davis Island.
South Tenth Street, Pittsburg.	1.3	Iron truss; highway	3	500	53	Do.
Homestead (Dickson Street).	7.5	Iron truss; railway and highway.	3	500	53	No. 1, Monongahela River.
Braddock, Thirteenth Street (1).	11.2	do	3	361.3	56.7	Do.
Braddock, Thirteenth Street (2).	11.2	Iron truss; highway	4	500	60 to 83	Do.
Pittsburg, Monongahela and Wheeling R. R.	32.6	Iron truss; railway	3	500	53	No. 3, Monongahela River.
Youghiogheny Central Rwy. Co., near Dawson.	51	Railway	3	95	20	Youghiogheny River.

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Ferry Street, Pittsburg	Mar. 2, 1895	May 20, 1896	1 year from date of act	3 years thereafter.
South Tenth Street, Pittsburg.		[a]Oct. 22, 1894		
Homestead (Dickson Street).	June 7, 1894	Sept. 20, 1894	do	Do.
Braddock, Thirteenth Street (1).	Feb. 18, 1893; amended May 4, 1896.	Oct. 2, 1896	1 year from Feb. 18, 1896.	Do.
Braddock, Thirteenth Street (2).	Jan. 26, 1897	Apr. 10, 1897	1 year from date of act	Do.
Pittsburg, Monongahela and Wheeling R. R.	Mar. 2, 1895	Sept. 12, 1895	do	Do.
Youghiogheny Central Rwy. Co., near Dawson.		[b]Sept. 24, 1892	2 years from date of act.	5 years thereafter.

[a] For rebuilding bridge.

[b] Company chartered by State of Pennsylvania.

D D 2.

OPERATING AND CARE OF LOCKS AND DAMS NOS. 8 AND 9, MONONGAHELA RIVER.

The locks were operated during the year, except when the walls were flooded by high water, from July 22 to August 3, and from February 22 to 25, and except when navigation was suspended by ice, from January 24 to February 9.

The number of monthly lockages for passing crafts were as follows:

Month.	Lock No. 8.	Lock No. 9.
1896.		
July	111	88
August	150	114
September	149	109
October	197	108
November	175	91
December	126	78
1897.		
January	47	29
February	36	16
March	123	93
April	143	97
May	167	107
June	140	96
Total	1,564	1,026

The work was under the immediate supervision of Mr. Philip Golay, resident engineer, from whose report the following are extracts:

LOCK AND DAM NO. 8, MOUTH OF DUNKARD CREEK.

During the winter of 1894–95, ice and high water lifted a portion of the sheeting of the dam. At the beginning of the fiscal year, July 1, 1896, a careful examination was made, and the injury to the dam did not appear to have been materially increased by intervening freshets; but during the latter part of July, an unusually heavy rainfall visited the portion of country drained by the Monongahela River and its branches, causing a flood of such violence as to carry away the sheeting and purlins from the central portion of the dam for a distance of 430 feet, leaving only 95 feet next to the lock wall, and 60 feet next to the abutment. Of these two sections, the sheeting and purlins, except for a distance of about 60 feet from the lock wall, were disturbed so that they had to be removed and bolted down again. Repairs were begun in August and completed in December, without interfering with navigation. Nearly all the timber and iron carried away by the freshet was recovered and used in the repairs.

The July freshet also filled the lock chamber and entrances with drift, threw up a bar along outside the lower end of the river wall closing the outlet of the turbine race, carried away about half of the sheeting of the guide crib below the lock, washed out the filling below the lower wing wall of the lock and poured over the T of the abutment on the left bank of the river, washing out about 30 yards of material immediately below the T. During high water in February, a crevasse started around the abutment. This has been temporarily closed. A dredge was employed to remove the bar outside of the river wall. It was a poor one, and succeeded only in opening the outlet of the turbine race. It yet remains to repair the guide crib below the lock, replace the filling below the lower wing wall, and make permanent repairs on the abutment on the left bank of the river. It is believed to be advisable to take down the abutment and rebuild it so as to conform with the slope of the bank.

New outbuildings (coal houses and closets) are needed, as those now in use have become old and dilapidated.

New closing chains for the lower gates are needed and have been ordered.

LOCK AND DAM NO. 9, HOARD, W. VA.

The freshet in the month of July deposited considerable material in the lock chamber and entrances. This was removed, partly by dredging and partly by flooding through the lock.

Additional riprapping is needed, both above and below the abutment on the left bank of the river.

Money statement.

July 1, 1896, balance unexpended	$20,739.46
Amount allotted for fiscal year ending June 30, 1897	19,232.84
	39,972.30
June 30, 1897, amount expended during fiscal year	24,851.71
July 1, 1897, balance unexpended	15,120.59
July 1, 1897, outstanding liabilities	721.46
July 1, 1897, balance available	14,399.13
Amount (estimated) for expenditure in fiscal year ending June 30, 1898	*13,070.87
Amount available for fiscal year ending June 30, 1898	27,470.00

ALLOTMENTS OF FUNDS.

August 15, 1884	$1,000.00	October 7, 1889	$1,500.00
September 1, 1884	4,000.00	November 6, 1889	1,200.00
November 3, 1884	4,500.00	July 24, 1890	12,300.00
December 20, 1884	500.00	July 8, 1891	24,250.00
June 1, 1885	100.00	July 21, 1892	34,017.86
July 22, 1885	1,000.00	July 21, 1893	23,574.72
July 10, 1886	1,200.00	July 23, 1894	25,664.00
March 1, 1887	1,100.00	July 12, 1895	20,372.40
July 1, 1887	11,000.00	July 28, 1896	19,232.84
July 11, 1888	6,270.00		
October 27, 1888	3,000.00	Total	197,261.82
July 17, 1889	1,480.00		

Statement of expenses incurred in operating and care of the locks and dams.

Month.	Operating expenses.				Repairs.				Tools and appliances.	Grand Total.
	Salaries.	Supplies.	Miscellaneous expenses.	Total.	Hire of boats and barges.	Labor.	Material.	Total.		
1896.										
July	$745.00	$11.98	$29.51	$786.49	....	$131.55	....	$131.55	$1.80	$919.84
August	775.00	1.15	39.83	815.98	....	861.40	$21.38	882.78	111.09	1,809.85
September	775.00	45.93	29.84	850.77	876.00	2,774.63	1,398.42	5,049.05	104.33	6,004.15
October	775.00	36.70	24.12	835.82	38.75	2,117.59	1,362.83	3,519.17	116.58	4,471.57
November	775.00	16.60	24.88	816.48	28.75	2,205.75	796.92	3,031.42	7.45	3,855.35
December	775.00	44.60	24.41	844.01	....	435.50	....	435.50	5.00	1,284.51
1897.										
January	775.00	3.20	23.91	802.11	5.00	156.54	....	161.54	....	963.65
February	1,000.00	1.85	34.91	1,036.76	....	61.65	4.75	66.40	....	1,103.16
March	1,000.00	....	26.28	1,026.28	5.00	121.35	11.25	137.60	....	1,163.88
April	960.00	4.02	51.76	1,015.78	....	....	.60	.60	....	1,016.38
May	1,075.00	9.17	46.37	1,130.54	....	....	3.33	3.33	....	1,133.87
June	1,075.00	14.81	107.45	1,197.26	....	....	2.40	2.40	....	1,199.66
Total	10,505.00	190.01	463.27	11,158.28	953.50	8,865.96	3,601.88	13,421.34	346.25	24,925.87

Commercial statistics are attached to the report of the improvement of the Monongahela River.

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*Amount allotted if estimate is approved.

D D 3.

PURCHASE OF LOCK AND DAM NO. 7, MONONGAHELA RIVER.

No steps were taken during the year for the separate purchase of this lock and dam, as the river and harbor act of 1896 provided for the purchase of all the property and appurtenances of the Monongahela Navigation Company, which since the close of the year have been acquired by the United States.

The funds for the purchase of Lock and Dam No. 7 can now be covered into the Treasury and the work dropped from Annual Report.

Money statement.

July 1, 1896, balance unexpended	$161,831.77
July 1, 1897, balance unexpended	161,831.77

D D 4.

PURCHASE OF LOCK AND DAM NO. 6, MONONGAHELA RIVER.

No steps were taken during the year for the separate purchase of this lock and dam, as the river and harbor act of 1896 provided for the purchase of all the property and appurtenances of the Monongahela Navigation Company, which since the close of the year have been acquired by the United States.

The funds for the purchase of Lock and Dam No. 6 can now be coverded into the Treasury and the work dropped from Annual Report.

Money Statement.

July 1, 1896, balance unexpended	$167,000.00
July 1, 1897, balance unexpended	167,000.00

D D 5.

CONDEMNATION OF ALL THE PROPERTY AND APPURTENANCES OF THE MONONGAHELA NAVIGATION COMPANY.

The river and harbor act of June 3, 1896, authorizes and directs the Secretary of War to institute and carry to completion proceedings for the condemnation of all the property and appurtenances of the Monongahela Navigation Company, appropriates the sum of $5,000, or so much thereof as may be necessary, to pay the necessary cost of said proceedings, and authorizes and directs the Secretary of War to draw his warrant on the Treasury for the amount of the judgment and costs, if in his opinion the judgment is reasonable, appropriating the sum necessary for the payment thereof.

Condemnation proceedings were had and award was made of $3,761,615.46 for the condemnation and appropriation of all the property and franchises of the company.

Since the end of the year, and on July 7, final judgment was entered by the court, $3,601,615.46 paid to the Navigation Company, and the property transferred to the United States.

The balance of the amount of the award, $160,000, is retained by the United States as security for the cancellation of certain outstanding bonds issued by the company.

The property comprises seven locks and dams and appurtenances. Locks 1, 2, 3, and 4 are double locks; 5, 6, and 7 are single locks.

In the case of the separate condemnation of Lock and Dam No. 7 the United States Supreme Court decided, upon appeal by the Navigation Company, that the value of the franchise must be considered in the making of the award.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	.22
July 1, 1897, balance unexpended	4,999.78
July 1, 1897, outstanding liabilities	Not known.
July 1, 1897, balance available	Not known.

SLACK-WATER SYSTEM ON THE MONONGAHELA RIVER, CREATED BY THE MONONGAHELA NAVIGATION COMPANY.

A brief history of the works of the slack-water system, created on the Monongahela River by the Monongahela Navigation Company, and an account of the steps leading to their acquisition by the United States may be of interest and are therefore appended, together with an explanation, and estimate of cost, of the betterments needed to put the waterway in a condition to afford adequate accommodation for its large and rapidly growing traffic:

THE RIVER AND ITS IMPROVEMENT WORKS.

The Monongahela River drains an area of about 7,000 square miles, and unites with the Allegheny to form the Ohio River at Pittsburg.

In its natural condition, prior to 1840, it was during low stages a shallow stream, being navigable for light-draft flatboats only a few months in the year. Its average width in the first 20 miles is about 1,000 feet, diminishing to about 650 feet between banks at the mouth of the Cheat River, which point is about 87 miles above Pittsburg. Its average descent on this part is about 0.9 foot per mile. There are no islands on this portion of the river, and its banks, where low being of alluvial formation, are subject to erosion by high waters, which frequently reach 30 feet, below the West Virginia State line, and upon two occasions have reached 42 feet above low water mark.

The general course of the river is nearly due north in Pennsylvania, but it makes so many bends that its length from the Virginia State line to Pittsburg is nearly double that of the air-line distance, being as 92 to 53 miles. The river hills skirting its banks rise to a height of 300 to 400 feet above the river bottoms, which are generally narrow and appear alternately on the right and left, and never on both sides in the same reach of river. At occasional places the bottoms are subject to overflow. The Pittsburg coal vein appears in the river hills (accordingly as the stream cuts through the geological series, which dips to the southwest), at from 330 feet above low-water surface to water's edge, and it actually passes beneath the water for a number of miles in the fifth and sixth pools, being about 300 feet below it at one point.

The first survey of the river was made for the State of Pennsylvania by Mr. E. F. Gay, C. E., in 1828, but no work of improvement was then authorized. In 1833 Congress provided for a survey of the river from Pittsburg to Brownsville, a distance of nearly 57 miles. The object of the improvement then proposed was to afford an outlet for the emigrant travel and traffic moving west by the National road, where, at Brownsville, the first navigable stream west of the Allegheny Mountains was encountered on that famous highway. This survey was made under the direction of Dr. William E. Howard, United States civil engineer. The proposed locks were to have only 4½ feet lifts. Congress failing to provide means for any work, the legislature of Pennsylvania, by act dated March 31, 1836, incorporated and authorized the Monongahela Navigation Company to improve the river from Pittsburg to the Virginia State line, a distance of 90½ miles. The act limited the lifts at the proposed locks to 4½ feet, a provision which it was thought would impose the least impediment to the movement of rafts and flatboats over the dams in times of freshets. The people of the valley above Pittsburg in general were hostile to any improvement, the existing navigation being nearly all downward in floating craft.

The first surveys made by the navigation company were under the direction of W. Milnor Roberts, chief engineer of the company. The result of these surveys developed the fact that to reach the Virginia State line 17 dams would be necessary to comply with State laws; but at the request of the company, in June, 1839, the legislature authorized lifts of 8 feet between pools, and at a still later period the company was authorized to increase the lift of its locks, commencing at No. 4, so that not more than seven dams would need to be constructed for extending the navigation to the Virginia State line.

Locks and Dams Nos. 1 and 2 were completed in 1840, and considerable progress had been made at Nos. 3 and 4, which were not completed, however, until 1844, when the navigation was extended to Brownsville. These locks have chambers 50 feet wide by 190 feet between quoin posts, or 158 feet useful length.

Pending the completion of the slack-water to Brownsville, mass meetings of citizens were held at several points in opposition to the extension of slack-water, and feeling ran so high that threats were made to destroy Dams Nos. 1 and 2, but after the completion of Nos. 3 and 4 the advantage of perennial navigation became so patent that there was an entire revulsion of feeling in the matter.

The depth of water provided by the four dams below Brownsville was 6 feet, though in occasional periods of drought not more than 4 feet depth was actually maintained in the channel and upon the miter sills of the locks, the insufficiency of depth being due to excessive leakage of some of the dams, a defect which was remedied in later years. In 1848 second locks of larger dimensions than the first constructed were added at Dams Nos. 1 and 2 in response to the demands of the coal trade which, at this time, may be said to have first sprung into a position of importance. The new locks were 250 feet in length between gates, having useful lengths of 216 feet, by 56 feet widths. Locks and Dams Nos. 5 and 6, above Brownsville, were completed in 1856, and No. 7 in 1883. These locks were of the same size, or nearly of the same size, as the small locks at Dams 1, 2, 3, and 4.

The coal operators, finding it more profitable to mine coal in the upper pools, the vein increasing in thickness in that direction, the navigation company, in response to the demands of the trade, constructed a second lock at Dam No. 3, followed, in 1885, by a second lock at Dam No. 4. The dimensions of these new locks are, at No. 3, 313 feet between gate quoins, by 56 feet width; at No. 4, 262 feet between gate quoins, by 56 feet width between lock walls.

Although by the terms of its charter the navigation company was obliged to extend navigable water to the Virginia State line, at the instance of Col. Wm. E. Merrill, Corps of Engineers, and Gen. J. K. Moorhead, president of the navigation company, an arrangement was made by which the United States was to construct Dam No. 8, 2 miles below the State line. This arrangement permitted of a less lift at No. 7 than would otherwise have been necessary to extend navigation for loaded boats to the State line.

In 1895, and again in response to the demand of the coal trade, the chamber of the lock at No. 5 was lengthened 6 feet, so as to enable coal boats 170 feet in length to be locked through. It was not possible, without lengthening the walls at No. 5, to extend the lock chamber by more than 6 feet.

The progressive tendency to move up the river in developing the coal fields, shown by the necessity of enlarging the facilities at Dams Nos. 3, 4, and 5 in recent years, has not yet ceased. So with the new mines now opened and being opened in Pool No. 5, the facilities at Dam No. 5 will be in a short time totally inadequate to meet the demands of the trade.

All the locks of the navigation company are of masonry, the walls of the earlier locks having widths of base of 11 to 12 feet; those of a later period, 13 to 15 feet. The walls vary in height from floors to copings from 23½ to 26 feet. The stone for all the locks, with the exception of the second lock at No. 4, was quarried from the river hills within a mile or two of the location of the particular works. It was found that but little of this stone would withstand the action of time and the weather. The decomposition of the stone in some of the lock walls, especially in the belt of masonry involving the lift, which after being soaked with water was exposed suddenly to a cold temperature, proceeded to such an extent that such portions were sheathed with oak plank laid in two courses, spiked to studding let into the walls. The irregular voids back of the planking were filled with concrete. The side of one lock chamber so repaired in 1861 is still serviceable. A number of the locks are in such a condition now as to require similar treatment in the near future. At the new or second lock at Dam No. 4, stone from the Beaver River Valley was used in the construction of the walls, and after twelve years' exposure it appears to show no tendency to disintegration.

The locks at Dam 1 rest on a smooth floor of solid rock, the outer lock, however, having timber floors overlying the rock. In the floor of the old lock a recess was left about midway between the present gates for the introduction of a bear-trap gate on the plan which had been in use on the Lehigh River, Pennsylvania, as early as 1819. It was probably the idea to use the middle gate for locking small boats so as to economize in the use of the water, but there is no record that the bear-trap gate was ever placed in position.

At Lock No. 2 the foundation is gravel and sand, and rather soft, being such material as would require, according to modern practice, either pile work or deep excavation to secure the foundation. As it was, however, the walls were carried on a grillage of timbers, covered with two courses of planks and sunk not more than 3 feet beneath the original surface. Upon the building of the second lock at No. 2 trouble was experienced from leaks communicating between the locks beneath the floors. Time after time these leaks appeared, and grew so large upon one occasion as to threaten the collapse of the walls of the outer lock. Grouting in the aggregate of several occasions to the extent of the use of nearly 10,000 barrels of cement was resorted to, and it is believed the voids beneath the floor and walls are now thoroughly filled. The last work of importance in grouting was done about sixteen years ago.

At Lock No. 3, also, a soft gravel foundation was met with, so that when the second lock was added in 1883 much trouble was encountered. A portion of the new lock walls rests upon concrete foundations, but the major portion of the walls rests upon a single course of timbers laid transversely beneath the walls and across the chamber, these timbers being bolted together by means of driftbolts driven horizontally at intervals of a few feet. Here, as at No. 2, leaks developed between the two locks, with the result that sand flowing in the direction of the leakage gathered under the floor of the new lock, causing it to bulge upward as much as 7 to 9 inches in places. To stop this upheaval of the floor, in 1885 holes were cut on two lines of the floor parallel to the walls, piles driven through the holes, and the floor timbers secured to the piles by iron straps. This floor may be said, therefore, to be pinned down to resist upward pressure. The raising of the floor was accompanied by a leaning inward of the lock walls. For several years past no specially noticeable increase in the settlement of the walls has occurred. As originally built the new lock walls were given an outward batter of 7 inches from base to coping, but in some places this batter has been neutralized by settlement, and partly by an inward lean, amounting to several inches, affecting slightly the available width of the lock chamber.

At Nos. 4 and 5 the lock walls and dams and abutments rest on gravel. The same general plan of timber foundation was adopted here as at No. 2, the only difference being in the case of the new lock at No. 4, where, under the gates at each end of the lock for a length of about 50 feet, three courses of 1 foot square foundation timbers were laid, the bottom and third course being laid across the chamber and the intermediate course lengthwise of the lock, and all three courses bolted together both horizontally and vertically.

It having been found impossible to drive piles in the chamber of the new lock at No. 4, and as a precaution against the tendency of the upward pressure to raise the timber floor, an excavation 20 feet wide and 2½ feet deep was made in the middle of the chamber throughout its length. In this trench a box filled with concrete was placed and attached to the floor, the monolithic slab of concrete acting as a counterweight to resist upward pressure. So far this expedient has proved satisfactory.

At Dam No. 6 the lock rests upon a stratum of limestone which is somewhat fissured; the fissures have, in the course of time, developed considerable leakage beneath the lock walls.

At Dam No. 7 the lock walls rest upon solid rock, excepting at the lower end of the river wall, where, for a distance of about 40 feet, the masonry is founded upon timbers, said to have been placed for filling a depression or offset in the natural rock bed.

As a summary it can be said that at no point on the lower Monongahela does a rock bed extend entirely across the river within reach of ordinary means of sinking foundations. Only one of the midstream piers of the numerous bridges crossing the river has reached the rock; all of the others rest upon cribs or timber platforms sunk in pits dredged to a depth of about 12 feet below the river bed.

Originally the lock gates rested on wheels, moving over a track laid upon a segment of a circle, and submarine chains were used in moving the gates; but these were long ago done away with, the gates being now suspended in accordance with modern practice for gates of moderate widths and at low lifts. Pontoon or hollow gates of boiler plate iron have been tried upon the river, but the expectation that they could easily be kept free from water, and therefore by their displacement light and easy to operate, was never realized. One pair of such gates, which cost $13,500, was discarded after use about 1892, and wooden gates substituted. At the lower locks the upper and lower gates are of the same depth, and both the filling and emptying of the chambers is effected through wickets in the gates (five wickets in each of the larger gates), the wicket rods coming to the top arm in the usual manner, and all, by means of a chain, connected to a hand winch on the wall, so as to be opened simultaneously. Experience on this river in filling the locks in the manner indicated has never shown such reaction of the water as to swamp or endanger boats or to snap their mooring lines. The only serious disasters to the gates arising from the traffic have been the result of mistakes in signals to the engineers of steamers in entering the locks; but trouble from this cause has been rare, as may be judged from the practice of not keeping duplicate gates on hand. The period of usefulness of the lock gates has been from twelve to thirteen years, their top arms having been usually repaired or replaced at the end of the ninth year. The gates at the upper end of the river, however, not being subject to so much use, last a year or two longer. The gates have posts at each end, though some built-up gates, i. e., gates with full-length arms spaced with blocks and drawn together with rods, have been tried. The gates are maneuvered by friction machines operated by shafting on the lock walls, the motive power being either steam or by water wheel.

At Lock No. 1 the boilers and engines for operating the land-wall gates are on shore, a steam pipe being carried by means of a bridge affording 62 feet clearance above the lock walls to an engine on the middle wall, which engine in turn operates two lines of shafting. An undershot water wheel, placed at the end of the dam, furnishes the power to operate the gates on the river wall of the outer lock. Capstans at convenient points are provided to assist in pulling in and out boats, rafts, etc. During 1886 more than 35,000 crafts of various kinds were passed through the locks of Dam No. 1, in addition to more than 700 rafts. Steam power is necessary to operate the gates at Lock No. 1, because of the frequent occasions of loss or diminution of head of water power caused by back water from Allegheny River freshets. A steam engine is used on the wall between the two lock chambers at Dam No. 2. The gates on the land side of the inner lock, and those on the river wall of the outer lock, are operated by water power. Water power is alone used at Locks Nos. 3 and 4, excepting upon one wall at No. 4, where hand power is used; at Nos. 5, 6, and 7, hand power alone has been used. The facilities for operating the lock gates at Nos. 4 to 7 are in need of improvement.

A section of the dams on the Monongahela resembles a log cabin, a name which has been applied to this form of crib-dam structure. The width at base of the dams varies from 56 to 60 feet, the slope from the crest being 1 foot vertical to 3 feet horizontal. The pockets or compartments of the dam are about 10 feet square and are filled with stone. The upper slope is sheathed with a double thickness of oak plank, with a third or "protection" course extending from the crest halfway down the slope, having 6 inches thickness at the crest, tapering to 3 inches at the lower end. The lower slope is composed of hewed oak timbers 10 inches to 12 inches thick, generally the full length of the slope, and laid with 1 inch open spaces. Ordinarily from the "eaves" of the dam to the river bed the depth is 10 feet, and on the upper side two courses of close sheeting have been driven. The gravel filling extends from 60 to 100 feet above the dam.

This form of dam has proved very serviceable on the Monongahela. None of the dams have failed from undermining, but on five occasions their tops have been cut down by heavy ice, making breaks of as much as 200 feet in length, with a scour of fully 40 feet in the gap. It is reported that the employees of the company have on each occasion of a break in the dams closed it by floating downstream and sinking cribs, without resorting to a V or temporary dam. This is the more notable since the breaks have occurred late in the winter or early spring, when powerful currents had to be contended with.

At Dam No. 1, located about 1¾ miles above the mouth of the river, it very frequently happens in the winter and spring months that freshets from the Allegheny River back up the Monongahela so that it is practicable and safe for loaded vessels to pass over the dam. The Navigation Company, in order to lengthen the periods when navigation over the dam would be safe, especially for the downstream traffic, in 1882 placed a bear-trap gate, devised by Mr. John Dubois, at the middle of the dam. The opening provided was 120 feet long. The crest of the dam was cut down 8 feet, and the bear trap placed with its hinged axis at the foot of the lower slope of the dam. Guide cribs were provided to afford safe entrance to the "Dubois chute," as it was called. In the initial experiment structural weakness in the gate was discovered, and, although $40,000 had been spent, nothing was done to remedy the difficulty. Not a single vessel passed through the chute. The whole device was abandoned, and the gap in the dam permanently closed.

For valuable assistance in preparing the foregoing history and upon other portions of this special report I am indebted to Mr. Thomas P. Roberts, assistant engineer, and for the last fourteen years chief engineer of the Monongahela Navigation Company.

STEPS LEADING TO THE ACQUISITION BY THE UNITED STATES OF THE LOCKS AND DAMS AND THEIR APPURTENANCES.

During the years 1883 and 1884 a concerted movement was inaugurated by the coal operators and dealers in Pittsburg and elsewhere along the Ohio favoring the purchase of the locks and dams of the Monongahela Navigation Company by the United States and making them free of tolls. It was argued, apparently with much reason, that, as the Government was then engaged in improving the Kanawha River in West Virginia, by means of a system of locks and dams which would enable the West Virginia coal from the Kanawha Valley to reach the Ohio free of tolls at a point 261 miles nearer the markets of the West and South than the mouth of the Monongahela, the Pittsburg operators would experience great difficulty in competing in the future with the West Virginians, hampered as the former were with a toll charge on coal amounting, upon an average, to 6½ cents per ton.

The river and harbor act of August 5, 1886, provided that—

> The Secretary of War is hereby authorized and directed to ascertain the value and commercial importance of the works and property * * * of the Monongahela Navigation Company, situated on the Monongahela River, in the State of Pennsylvania; and in order to acquire such information the Secretary of War shall appoint a Board of three competent engineers from the Engineer Corps of the United States Army, which Board shall * * * report to the Secretary of War, who shall report thereon to Congress at its next succeeding session; and the cost of such examination shall be paid out of the sum appropriated by this act for surveys: *Provided*, That nothing herein shall be construed as committing Congress to the purchase of said works.

The report of the Board of Engineers, constituted in pursuance of this act, will be found in House Ex. Doc. No. 112, Forty-ninth Congress, second session. It was republished in House Ex. Doc. No. 249, Fifty-third Congress, third session.

The Board fixed the value of the tangible property of the Monongahela Navigation Company at $1,950,000, and suggested that the valuation of the company's capital stock be made the basis for determining the value of the entire property, including the franchise to take tolls. The Board expressed the opinion that the commercial importance of the Monongahela is very great, and that the river properly belongs to the United States.

The river and harbor act of August 11, 1888, provided for the amicable purchase of Lock and Dam No. 7, at a cost not to exceed $161,733.13, being the amount named for this particular lock and dam by the Board of United States Engineers. It was further provided in the act that—

> In the event of the inability of the Secretary of War to make voluntary purchase of said Lock and Dam No. 7 and its appurtenances for said sum of $161,733.13, or a less sum, then the Secretary of War is hereby authorized and directed to institute and carry to completion proceedings for the condemnation of said Lock and Dam No. 7. * * * *Provided*, That in estimating the sum to be paid by the United States the franchise of said corporation to collect tolls shall not be considered or estimated.

Upon the refusal of the navigation company to sell Lock and Dam No. 7 under the terms of the act, condemnation proceedings were instituted. The case was heard before a Board of Viewers, appointed by the circuit court of the United States for the western district of Pennsylvania. The value of the work in question was fixed by said Board at $209,393.52, without reference to the value of the franchise. Exception to this verdict was filed by both Col. William E. Merrill, Corps of Engineers, U. S. A., representing the Government in the case, and by the navigation company. The case then came up before the court in November, 1890, for final hearing, and the verdict reached was for $209,000.

The act of Congress having provided that either party might appeal to the United States Supreme Court, the navigation company appealed the case to that court, which rendered an opinion, given in No. 722, October term, 1892, and in which it was affirmed that the—

> Franchise was as much a vested right of property as the ownership of the tangible property; that the right of the National Government under its grant of power to regulate commerce, to condemn and appropriate this lock and dam belonging to the navigation company, is subject to the limitations imposed by the fifth amendment, that private property shall not be taken for public use without just compensation; that just compensation requires payment for the franchise to take tolls as well as for the tangible property, and that the assertion by Congress of its purpose to take the property does not destroy the State franchise. The judgment will therefore be reversed, and the case remanded with instructions to grant a new trial.

The river and harbor act of September 19, 1890, provided for the condemnation of Lock and Dam No. 6, and appropriated $162,000 for this purpose, stipulating, however, that the title to Lock and Dam No. 7 must first be secured to the Government before proceedings could be instituted for the purchase and condemnation of Lock and Dam No. 6. Nothing further was done until the river and harbor act of August 17, 1894, authorizing the Secretary of War to investigate and report the sum of money necessary to acquire by purchase all the locks and dams, the property of the Monongahela Navigation Company, and to take testimony as to the value of the said improvement and the commercial usefulness of said river, to the end that Congress might determine as to the expediency of making the navigation of said river free of tolls.

Upon the recommendation of the Chief of Engineers the Secretary of War designated Maj. R. L. Hoxie, Corps of Engineers, to receive testimony regarding the value of the property of the Monongahela Navigation Company. The report of the Chief of Engineers, embracing the report of Major Hoxie, was submitted to the Secretary of War December 12, 1895, and is printed as House Doc. No. 78, Fifty-fourth Congress. In his report Major Hoxie expressed his opinion that the least valuation through the process of condemnation of the property and franchise of the Monongahela Navigation Company would be $3,634,720.

The final act of Congress relating to the Monongahela Navigation Company, passed June 3, 1896, authorized and directed the Secretary of War to institute and carry to completion proceedings for the condemnation of all the company's property and its appurtenances, and appropriated $5,000, or as much thereof as might be necessary, to pay the necessary cost of said proceedings, and authorized and directed the Secretary of War to draw his warrant on the Treasury for the amount of the judgment and costs for the payment thereof, if in his opinion the judgment was reasonable, and appropriated the sum necessary for the payment thereof.

In pursuance of this act a Board of seven viewers was appointed November 27, 1896, by the circuit court of the United States for the western district of Pennsylvania to estimate and determine the value of all the property and its appurtenances of the Monongahela Navigation Company. The Board rendered its report to the court March 25, 1897, awarding damages to the navigation company, including the value of all its property and its franchise, in the sum of $3,761,615.46.

No appeal from this award was taken, and final judgment was entered. A warrant was issued in favor of said company to the amount thereof, less the sum of $160,000 withheld in the United States Treasury as security for the payment of outstanding bonds of the company. On the afternoon of July 7, 1897, the locks and dams and their properties and appurtenances were transferred to the United States, and the locks opened to free navigation.

ENLARGEMENTS AND OTHER IMPROVEMENTS REQUIRED TO MEET THE DEMANDS OF TRAFFIC.

Since 1886, the year of the first act of Congress looking toward the acquirement by the National Government of the properties of the slackwater system, the navigation company had done nothing toward increasing the facilities at its several locks and dams, excepting, as was related above, in lengthening the chamber of Lock No. 5 6 feet in order to pass, singly, small-sized coal boats. It is a fair presumption, in regard to the future of the Monongahela, that with the freeing of the river from tolls the business at the several locks will increase, and if, as has been confidently stated by coal operators and others engaged in the passenger and general freight business, the traffic has suffered for the lack of adequate facilities in the past, and which seems correct, the demand for the enlargement and betterment of the works will become more imperative.

A little more than a month only has elapsed since the Government obtained control of the locks and dams on the Monongahela River, but a noticeable increase in the use of the locks, especially by passenger steamers and miscellaneous harbor tugs, excursion barges, etc., has been observed in this time. During July there were 1,683 lockages at Dam

No. 1; coal to the amount of 325,438 tons passed through No. 3; of timber and lumber, 608,325 cubic feet and 546,640 feet B. M., respectively, passed Lock No. 1; and 33,779 passengers were on boats locking at Lock No. 2. The large number of passengers is due to summer excursions, prevented before by the tolls. While much coal had been held afloat in Pool 4 awaiting free lockage, and when that obtained was moved rapidly, on the other hand the coal movement almost stopped during the latter half of July on account of strikes at the mines.

The brief period under review has witnessed the establishment of a new daily line of passenger steamers running from Pittsburg to Morgantown, 105 miles, and a new daily line boat in the trade between Pittsburg and Monongahela City, 32 miles. There are now nine daily passenger boats on 105 miles of river, four of them in the through business and five plying between intermediate points. The harbor of Pittsburg may be said to embrace Pools Nos. 1 and 2, upon the banks of which are located numerous iron and steel mills, glass works, etc., and in which coal tows are harbored. On the second pool, Homestead and Braddock alone have a population estimated at 30,000. In the third pool, the city of McKeesport has 35,000 population, with Duquesne, Oliver, Dravosburg, and Elizabeth having 10,000. On these pools, 1, 2, 3, and also 4, are located the principal boat-building yards, coal hoisters, dry docks, marine railways, sawmills, etc.

The interchange of commodities by the mills and the requirements of the boat yards, etc., especially since the freeing of the river, has greatly increased the harbor business, and thus it is that at Dams Nos. 1 and 2 the need of enlarged facilities is more urgent than elsewhere, though the necessity for improvement at the locks above can not be overlooked, and provision for satisfying which should not be postponed.

The coal trade is erratic in the periods of its activity, dependent as it is so largely upon the navigability of the Ohio, the opening and closing of the iron mills in Pittsburg, strikes of the miners, etc., so that proper comparison of its growth or decline can be drawn only from annual reports.

The aggregate of tonnage of freight, principally coal, but including iron and miscellaneous articles, on the Monongahela River for the last five years was as follows:

	Tons.		Tons.
1892	4, 163, 304	1895	4, 555, 703
1893	4, 142, 644	1896	5, 989, 159
1894	4, 918, 089		

Showing a traffic next in order, on the interior waterways of the United States, to that of the St. Marys Falls Canal.

The restrictions to the desired accommodation of the coal traffic on the river are the insufficiency of lockage capacity and of reliable depth of water on the sills and in the pools at low stages. Experience has apparently demonstrated, considering the channel limits and size of towboats useful for the pools, that a fleet carrying some 3,000 tons on 8 feet draft is about the limit of safety, and that the disposition of the tonnage in three coal boats, 175 feet long by 26 to 27 wide, is the most convenient. As it is now, no lock on the river will pass such fleet excepting at two or more lockages, causing a separation of the fleet, loss of time, and detention to other crafts awaiting lockages. To add an additional lock at a dam where there are now two locks would be only a partial relief; it is impracticable to put a third lock on the land side, and inadvisable to put the extra lock at the opposite end of the dam, and especially inadvisable to shorten the crests of any dam. As the second locks at Dams Nos. 1, 2, 3, and 4 have widths of 56 feet they would require only lengthening at one end to give available chambers of 350 feet long in order to become immediately useful in passing a fleet of the proposed standard of dimensions at a single lockage. The position of the harbor line and other restrictions about No. 1, and the fact that here the most numerous lockages are necessary, appear to dictate the construction of a new lock of the dimensions proposed, to take the place of the existing small lock. With this new lock built, and the larger locks at Nos. 2, 3, and 4 lengthened, and a second lock built at No. 5, the facilities for transporting coal on the Monongahela River would be greatly improved.

It would be important, upon a river floating such a large commerce, to have the work carried on simultaneously at all the locks, in order to reduce to a minimum interference to existing navigation.

To accommodate the 7 to 8 foot draft coal barges and boats, the navigation company for a number of years past, during the summer, attempted by means of temporary flashboards placed on the dams below Pool 5, to increase the depth on lock sills and in the pool channels from 2 to 2½ feet. The expedient of the flashboards, so long as they could be maintained in position, generally served the purpose fairly well, but as they were liable to be carried away in whole or in part by even small freshets or drift, their maintenance involved considerable expense, and interfered with regular duties of the repair force; besides, when a section of 50 to 100 feet in length of the boarding was carried away, the current developed through the gap created eddies, which impeded vessels at the lower entrance to the lock. To neutralize the obstructive eddy a section of the temporary dam next to the lock was sometimes removed, causing more work in replacing the boards, and delay to loaded coal boats when the river dropped again to low stage. The navigation company was restricted by its charter to a fixed height of dam, but as no such restrictions now remain, there is no reason at present known why the crest of the dams should not be raised to a height sufficient to afford a least depth of 8 feet through the pools of the first, second, and third dams.

Dam No. 4, affording as it does a depth of only 4 feet on the lower sill at Lock No. 5, might be with much advantage raised permanently about 2 feet and provided with a form of iron or steel permanent adjustable top to add 2 feet more during the summer, so that 8 feet would be maintained in the channel at the upper end of the pool and in the lock at No. 5. The same comparatively inexpensive method of increasing the depth in Pools 6 and 7 would also be advisable.

While it is improbable that a permanent increase in the height of the dams, 1 to 4, of 2 feet would increase the height of the great floods, it would be advantageous at all the dams to somewhat lengthen their crest lines. The lengthening of the dams would shorten the duration of the period when the locks are thrown out of use by floods of intermediate height. Most of the locks are now flooded by rises of 20 to 22 feet. It is true the freshets above this height are usually short lived, and at such periods towboat navigation is suspended, but it has been a frequent occurrence for the packets to lose a day at a lock which could not be operated by reason of a shallow depth of water flowing over the lock walls.

In suggesting an increase in the height of the dams where practicable, to accommodate the growing needs of the coal trade, it is deemed advisable to provide in the estimate for betterments for the raising of every lock wall correspondingly, viz, where a dam is raised 2 feet, the lock walls to be raised the same height, otherwise there would result, with the raising of the dams, more frequent flooding of the lock walls than now occurs. Besides raising the dams, dredging of pool channels at certain places is needed.

Another desired and important improvement recommended is the lengthening of the fender and mooring cribs in the vicinity of a number of the locks. It frequently occurs that several fleets of boats meet above and below locks awaiting their turn to be passed through, and in stormy weather or high water they should have a safe place to land and tie up and at such distance from the locks as not to be in the way of vessels which may be in the act of entering or clearing the locks. To extend the existing cribs on the lines recommended will, of course, require considerable dredging, but the result will be a material straightening of the channel at the very points where the greatest benefits will accrue.

The smaller locks should be used by packets as well as other single craft, and to accommodate the packets as much as can reasonably be done it is proposed to lengthen the chambers of the small locks at Dams 2, 3, 4, 5, 6, and 7 by setting the lower gates back 6 feet.

The estimate following has been made in accordance with the above brief project, and to provide adequate means of removal of obstructions in the pools and needed additional machinery and buildings:

SUMMARY OF ESTIMATE OF COST OF NECESSARY ENLARGEMENTS AND OTHER IMPROVEMENTS.

At and near Lock No. 1.

Dredging for channel from near Smithfield Street Bridge to lower entrance of lock, including pile footing of bank pavement	$33,360.50
Removing part of old fender and mooring crib and building new crib 1,000 linear feet along harbor line below lock	28,500.00
Property damages resulting from same	12,000.00
Building fender and mooring crib 500 linear feet along harbor line above lock, to join with existing pile revetment	12,500.00
Removing part of smaller lock and rebuilding same to give useful dimensions of chamber, 56 feet by 350 feet, with 8 feet depth on lower sill at pool level and 2 feet greater height of walls	195,611.00
Raising walls of old lock 2 feet, adding a set of intermediate gates, and removing and replacing machinery	16,360.00
New and raised foundations for engine houses and office and additional lock machinery	28,000.00
Raising dam 2 feet to give 8 feet depth over lower sill at Lock No. 2 and increased depth in Pool No. 1	27,473.35
Dredging for channel at upper approach to lock	8,040.00

At and near Lock No. 2.

Dredging for channel from near the mouth of Turtle Creek to lower entrance to lock	22,151.00
Deflecting dike at mouth of Turtle Creek	2,150.00
Mooring and fender crib 935 linear feet along harbor line below lock	18,700.00
Building fender and mooring crib 760 linear feet, making same 1,000 feet long at upper approach to lock, and deflecting dike above upper end of lock	16,820.00
Lengthening larger lock to give useful dimensions of chamber, 56 feet by 350 feet, with 8 feet depth on lower sill at pool level and 2 feet greater height of walls	106,830.12
Raising walls of smaller lock, removing and replacing machinery, and lengthening chamber of small lock 6 feet	17,120.00
New and raised foundations for engine houses and office and additional lock machinery	6,400.00

Raising dam 2 feet higher to give 8 feet depth over lower sill at lock No. 3 and increased depth in pool No. 2; removing timber abutment and replacing same with a stone-sloped abutment	$32,197.60
Dredging for channel at upper approach to lock	2,500.00
Lengthening dam 60 feet	20,200.00

At and near Lock No. 3.

Dredging channel below lock	4,800.00
Extension of fender and mooring crib 800 linear feet along shore below lock to connect with existing crib	16,000.00
Extension of existing fender and mooring crib 300 linear feet above lock and building deflecting dike 1,800 feet above lock	7,600.00
Extension of larger lock to give useful dimensions of chamber, 56 feet by 350 feet, with 8 feet depth on lower sill at pool level and 2 feet greater height of walls, including purchase of 2 acres of land	82,315.00
Raising walls of smaller lock, removing and replacing machinery, and lengthening small lock chamber 6 feet	22,960.00
New and raised foundations for engine houses and office and additional lock machinery	3,000.00
Raising dam 2½ feet to give 8 feet depth over lower sill at Lock No. 4 and increased depth in pool No. 3; removing timber abutment and replacing same with masonry-sloped abutment	38,810.25
Dredging for channel at upper approach to lock	1,080.00
Lengthening dam 112 linear feet, making total length 800 linear feet	30,950.00

At and near Lock No. 4.

Dredging for channel at lower entrance to lock	3,000.00
Extending fender and mooring crib 690 linear feet at lower entrance, making a total length of 1,000 feet	17,250.00
Raising fender and mooring cribs and ice breakers above lock 3 feet.	4,575.00
Lengthening larger lock to give useful dimensions of chamber, 56 feet by 350 feet, with 8 feet depth on lower sill at pool level and 2 feet greater height of walls	87,134.00
Removing and rebuilding a portion of smaller lock, lengthening lock 6 feet, sheeting one side of chamber, raising walls 2 feet, and removing and replacing old machinery	38,940.00
New office building, with new and raised foundations, and additional lock machinery	5,700.00
Raising dam 2 feet to give 6 feet depth over lower sill at Lock No. 5 and increased depth in pool No. 4	17,246.00
Permanent adjustable iron flashboards for dam, to give 2 feet additional depths at low stages	5,720.00
Lengthening dam 112 linear feet, making total length 715 feet	30,950.00
Filling lock now subject to overflow, purchasing land, building new dwelling, and making minor improvements	21,390.00
Enlargement of repair shop, making new launching way, and raising overseer's dwelling above flood	10,000.00

At and near Lock No. 5.

Dredging for channel from Watkins Bar to lower entrance of proposed new lock	35,923.75
Removing old mooring and fender crib and building 1,000 linear feet new crib along shore below lock	25,000.00
Purchasing 4 acres of land below lock	800.00
Removal of old cribs and building new mooring and fender crib above lock and guard crib, or ice breaker, at head of river lock wall	31,000.00
New lock, including excavation, masonry, lock gates, paving slopes, etc., of useful dimensions of chamber, 56 feet by 350 feet, with 8 feet depth on lower sill at pool level and 2 feet greater height of walls than old lock	294,648.50
Raising walls of old lock 2 feet	2,280.00
New office building, dwelling for employees, and machinery (for two locks)	37,600.00
Raising dam 2 feet to give 6 feet depth over lower sill at Lock No. 6 and increased depth in pool No. 5	17,331.60
Lengthening dam 94 linear feet, making total length 700 feet, and new stone-slope abutment	30,000.00
Permanent adjustable iron flashboards for dam, to give 2 feet additional depths at low stages	5,600.00

At and near Lock No. 6.

Dredging below entrance to lock, including rock removal	$1,550.00
Mooring and fender crib below lock, 400 linear feet	10,000.00
Mooring and fender crib above lock, 250 linear feet	5,000.00
Lengthening lock chamber 6 feet, and concreting lock floor	8,480.00
Raising walls of lock 2 feet and changing slope wall	4,380.00
Dwelling for employees and machinery for operating lock gates	19,900.00
Raising dam 2 feet to give 6 feet depth over lower sill at Lock No. 7, and increased depth in Pool No. 6	18,046.00
Lengthening dam 69 linear feet, making total length 700 feet, and new stone sloped abutment	25,000.00
Permanent adjustable iron flashboards on dam to give 2 feet additional depths at low stages	5,600.00

At and near Lock No. 7.

Dredging and rock removal along shore at lower entrance	2,500.00
Mooring and fender crib below lock, 400 linear feet	6,000.00
Mooring and fender crib above lock, 400 linear feet	7,000.00
Raising lock walls 2 feet	2,280.00
Dwelling for lock tender, land for same, and new foundation wall of old dwelling	5,500.00
Removing portion of land wall of lock and rebuilding same	20,000.00
Lengthening dam 80 linear feet to make total length 605.5 feet, including bank paving below abutment	30,000.00
Permanent adjustable iron flashboards on dam, 605.5 linear feet, to give 2 feet additional depth in pool and on lower sill of lock above	4,844.00
Machinery for operating lock gates, including turbines	17,400.00

Miscellaneous items.

Dredging for channel at Brownsville, fourth pool	4,120.00
Dredging for channel at Millsboro, fifth pool	6,680.00
Steam launch	5,000.00
New repair steamer with snagging appliances	45,000.00
Dredge boat and two dump scows	35,000.00
Total	1,820,797.67

D D 6.

IMPROVEMENT OF ALLEGHENY RIVER, PENNSYLVANIA.

The object of this improvement is to give an open-river navigation for light-draft boats and for rafts, by means of contraction works and removal of obstructions.

Operations during the year comprised repairs to the dams and dikes and the removal of some obstructive rocks and snags. The work was under the immediate supervision of Mr. I. V. Hoag, jr., late assistant engineer.

Dam at Hickory.—One hundred feet of 10 by 12 inch timbers and adjacent paving which had been displaced by ice during the previous winter were replaced, restoring the work to its original condition. Materials used were 1,608 feet B. M. of oak timber and 140 cubic yards of stone. Seventy-five cubic yards of gravel backing were placed above the dam. The cost of the repairs was $377.23.

Dam at Tionesta.—Small undermining of the abutments had caused some settlement of the stone filling. One hundred and twenty-five cubic yards of riprap stone was used in restoring the filling to its former condition, at a cost of $104.80.

Red Bank Dike.—Decayed timber had permitted the displacement of some paving. Thirty-two cubic yards of stone was recovered from the river, and the paving restored, at a cost for labor of $23.62.

Cowanshannock dikes.—A few squares of paving had been scoured out and a part of the riprap stone protection to the bank disturbed by the ice. All of this was replaced by material gathered from the river bed, at an expense of $54.80.

Removal of obstructions.—On September 12 two small working parties, equipped for the removal of bowlders and snags which had been brought into the channel-way during the year, commenced operations at Tionesta, 152 miles above the mouth of the river. The parties covered 128 miles of river below that point, and suspended work on November 15. One thousand three hundred and seventy-three cubic yards of bowlders and 43 snags were removed from the river bed, involving an expenditure of $1,147.78.

The log chute at Corydon and the dams at Cornplanter, Pithole, and Six-Mile Island remained in good condition through the year. The dam at Nicholsons Island being abandoned, nothing was done with it. The condition of the dam changed but slightly. It is believed that no serious injury has been sustained by any of the structures on the river during the past winter. A small amount of paving has been displaced at the Red Bank Dike, and possibly on one or two other dikes. Owing to the contraction of the waterway by the Hickory Dam, considerable scour has taken place along the channel face of Hickory Island, and a portion of the lower end of the island has been washed away by the strong cross current.

It is expected, for the latter part of this summer, to protect the island against further action of the current, to make the needed minor repairs to dams and dikes, build a new dam at Nicholsons Island, and to extend the Red Bank Dike about 800 feet. This dike was designed to improve the most troublesome ripple on the river. As the dike fails to reach the summit of the bar, the improvement has only been partial.

The following extract from a report by Mr. J. W. Arras, assistant engineer, gives a history and description of the Allegheny River improvement:

> The first appropriation for this improvement was made in the river and harbor act of March 3, 1879. Almost every ripple and shoal on the river was at that time obstructed by bowlders varying in size from 1 cubic foot to many cubic yards. Many of the larger of these bowlders were exceptionally dangerous to navigation, because of their positions in the channel, but their most objectionable feature lay in the fact that, taken as a whole, they deprived navigation of fully 1½ feet of the low-water navigable depth of the stream, which to navigators is of the greatest value. There existed, also, in many instances, islands dividing the discharge of the river almost equally between duplicate channels and several extremely long shoals, scattering the water evenly in a wide, shallow sheet, thereby causing a vast amount of trouble. The method of improvement adopted in open-river navigation comprised, first, the thorough removal of all bowlders, snags, wrecks, and abandoned structures obstructing navigation, and, second, the closing, with low dams, of the inferior one of duplicate channels where islands existed, and the concentration of the flow of water within a narrow, defined channel by the construction of curved and spur dikes at extensive shoals.
>
> The work accomplished up to the present time has been done at a cost of, approximately, $218,000. It has resulted in practically clearing the channel, and for long distances the entire river bed, of obstructions, and in the erection of eleven separate structures for the improvement of the channel at nine different localities. The former accomplishment involved the removal of one boat wreck, the remains of the abandoned piers of the canal aqueduct at the mouth of Kiskiminetas River, about 1,400 snags, and more than 150,000 tons of rocks, the greater portion of which were reduced to manageable proportions with the use of dynamite and sledges, and hauled to the banks on drag sleds. In this direction little remains to be done aside from the removal of a limited number of smaller bowlders brought to light from year to year by freshets and ice gorges.

The following is a list of the structures erected, and their locations, etc.

Locality.	Distance from mouth.	Structure.	Length.	Heighth above low water.	When constructed.
	Miles.		*Feet.*	*Feet.*	
Six Mile Island	6	Dam	700	3	1879
Nicholsons Island	37	do	1,000	3	1880
Cowanshannock	47	Spur dike	510	4	1895
Do	47.4	do	525	4	1893 and 1894
Do	48	Dam	402	2	1893
Red Bank	64	Dike	1,739	6	1889
Pithole	143	Dam	1,132	3	1891
Tionesta	152	do	298	2	1893
Hickory	157	do	730	3	1891
Cornplanter	204	do	334	3	1890
Corydon	209	Log chute	370	0 to 3½	1887

Except the dam at Cowanshannock, a simple riprap stone structure, these are all timber crib work, filled with broken stone, and paved with same on the top and slopes to a depth of from 12 to 18 inches. In addition thereto the Corydon log chute and Tionesta Dam on its lower slope have also a 6-inch oak covering for the protection of rafts passing over them. The elimination of timber from the upper portion of the Cowanshannock Dikes, and the substitution therefor of a stone-arched pavement, also marks a point of difference in their construction. These works have resulted in great good to the commerce of the stream, and, with the exception of Red Bank Dike alone, may be said to have accomplished the desired end. Corydon log chute has added much to the safety of rafting over the milldam across the main channel. Tionesta Dam has made it possible to bring the valuable product of Tionesta Creek into the Allegheny with perfect ease at any stage, and other structures have maintained an excellent low-water channel at all times in their respective localities. Red Bank Dike was designed to improve the most troublesome ripple on the river, and while it has been a great benefit, yet the strong cross current between it and the summit of the bar, which it fails to reach by a few hundred feet, is responsible for its failure to accomplish all that is required of it.

Annually slight repairs have been required on some of these works, for, as in all such structures in rivers with a clean, hard bottom, and carrying in suspension but a small quantity of light sediment, the interstices in the paving remain more or less open, thereby contributing to the displacement of the paving by the ice and freshets. The decaying ends of transverse timbers also cause breaches in the adjoining pavement. In this respect the dam at Nicholsons Island has been the greatest sufferer, and its annual repairs, necessitated by displaced paving, stone filling, and eventually crib work, have been a source of unusual expense. About two years ago the ice cut a gap of such proportions through the entire structure as to lead to its abandonment. Its location, perpendicular to the axis of the chute at a considerable distance below the head of the ripple, was largely responsible for the difficulty experienced in maintaining it.

Six Mile Island Dam, similar in design and location to that at Nicholsons Island, was also a source of much trouble until 1889, when, owing to a wide gap cut through it by the ice, the rear portion was reconstructed on a later design, since which time absolutely no repairs have been required.

Money statement.

July 1, 1896, balance unexpended	$19,694.29
June 30, 1897, amount expended during fiscal year	7,928.16
July 1, 1897, balance unexpended	11,766.13
July 1, 1897, balance available	11,766.13
Amount that can be profitably expended in fiscal year ending June 30, 1899	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

March 3, 1879	$10,000.00	September 19, 1890	$20,000.00
June 14, 1880	20,000.00	July 13, 1892	25,000.00
March 3, 1881	25,000.00	August 17, 1894	12,500.00
August 2, 1882	15,000.00	June 3, 1896	12,500.00
July 5, 1884	35,000.00		
August 5, 1886	30,000.00	Total	230,000.00
August 11, 1888	25,000.00		

COMMERCIAL STATISTICS.

[Compiled at United States Engineer Office, Pittsburg, Pa.]

The river trade is scattered over 350 miles of river, and it is impracticable to obtain full record of it. The amount reported is believed to be less than the actual tonnage of the river.

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Barges	6,156	Palings	51
Bark	4,200	Piles	4,113
Bottoms, coal boat	32,436	Poles, brace	3,000
Cattle	248	Posts, check	1,700
Coal	7,003	Posts, pit	5,717
Freight, general	3,600	Sand	110,225
Grain	360	Sheep	179
Gravel	29,253	Shingles	400
Hay	1,092	Staves	1,500
Hogs	136	Stone	18,579
Horses	315	Ties, railroad	875
Lath	500	Timber	104,013
Lumber	92,692		
Manure	8,325	Total	436,668

Passengers carried, 18,208.

In addition to the general commerce of the stream, the following are only the more important items of the local harbor trade in the Allegheny River at Pittsburg, viz, that part, 2¼ miles long, covered by the pool of the Davis Island Dam in the Ohio River.

Articles.	Quantities.	Articles.	Quantities.
	Tons.		*Tons.*
Cars, empty	86,700	Piles	180
Cars, loaded	605,990	Sand	167,873
Coal	405,119	Staves	690
Freight, general	2,580	Stone	6,400
Gravel	286,468	Ties, railroad	86,263
Lumber	36,000		
Manure	16,790	Total	1,701,053

Passengers carried, 9,685.

A comparison of the above with the statement of commercial statistics for 1892 shows an increase in the general business of the river of 23 per cent, and in the local harbor tonnage of 78 per cent. The latter trade is now confined to that portion of the river coming within the influence of the Davis Island Pool, a length of 2¼ miles, and a marked increase is sure to follow the completion of the Herr Island Dam, which will extend the navigable depth of the Pittsburg Harbor beyond the large manufacturing establishments.

Bridges completed over Allegheny River and its branches, not previously reported.

Name.	Distance above mouth.	Kind.	Spans.	Channel span.		Name of river.
				Clear width on low-water line.	Clear height above normal pool level.	
	Miles.			*Feet.*	*Feet.*	
Freeport	28.6	Iron truss, highway	3	290.5	45	Allegheny.

NOTE.—The Philadelphia and Erie Railroad bridge at Warren, Pa., 187.1 miles above the mouth of the river, was changed from a covered wooden truss to an open iron truss, the superstructure being erected on the old piers.

Bridges authorized and under construction at end of year.

Name.	Distance above mouth.	Kind.	Spans.	Channel span. Clear width on low-water line.	Channel span. Clear height above normal pool level.	Name of river.
	Miles.			*Feet.*	*Feet.*	
Butler and Pittsburg Railroad at Denny.	14.2	Iron truss, railroad...	4	500	55	Allegheny.

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Butler and Pittsburg Railroad at Denny.	June 11, 1896	Aug. 18, 1896	One year from date of act.	Three years thereafter.

Bridges authorized, but whose construction had not been commenced at end of year.

Name.	Distance above mouth.	Kind.	Spans.	Channel span. Clear width on low-water line.	Channel span. Clear height above normal pool level.	Name of river.
	Miles.			*Feet.*	*Feet.*	
Tarentum	20	Iron truss, highway..	4	298	45	Allegheny.
Kensington	20.3	.....do	4	300	45	Do.
Creighton	20.4	.....do	4	297	45	Do.

Name.	Date of issue of charter or approval of act of Congress.	Date of approval of plans by Secretary of War.	Date of commencement of work prescribed by charter or by act of Congress.	Date of completion of work prescribed by charter or by act of Congress.
Tarentum	....	July 10, 1893	Two years from date of charter.[a]	Five years thereafter.
Kensington	....	Apr. 28, 1894	.....do	Do.
Creighton	Mar. 7, 1893	Feb. 27, 1894	.....do	Do.

[a] Company chartered by State of Pennsylvania.

D D 7.

CONSTRUCTION OF LOCKS AND DAMS AT HERR ISLAND, ABOVE THE HEAD OF SIX-MILE ISLAND, AND AT SPRINGDALE, ALLEGHENY RIVER.

Of these works, the Herr Island Lock is under construction. This is a concrete lock of an available capacity of chamber of 55 feet by 286 feet 2 inches, with a least depth of water over the sills of 8 feet at pool level, and having a 7-foot lift. The lock and miter walls rest on concrete foundations, which were started from the bottom of a dredged pit 30 feet below the pool of the Davis Island Dam in the Ohio River.

At the beginning of the year the foundation walls had been built to a height of 22 feet below the Davis Island pool, a 2-foot concrete floor laid at the bottom of the pit over the chamber area, and a gravel filling made on the floor and against the sides of the pit outside of the foundation walls to 11 feet below pool level.

During the year the lock and head walls were completed, and the foundations of the miter walls partly laid.

The plan of foundation for the lock masonry was designed by Maj. R. L. Hoxie, Corps of Engineers, engineer in charge, after a cofferdam had proven unsatisfactory from excessive leakage through the loose gravel of the river bed. The work has been under the immediate charge of Major Hoxie, or of Mr. J. W. Arras, assistant engineer. The following is from a report by Mr. Arras:

Operations on the construction of this improvement began in June, 1893, and during that season the cofferdam for the lock was built and such further preparatory work performed as would provide an early start on the erection of the lock in 1894. Owing to some difficulty with leakage through and under the cofferdam, nothing of importance was accomplished that season until very late in the fall, when, under a change from the original plan of construction of the lock to one contemplating the erection of the foundation walls under water, the necessary excavation and a bare start on the construction of the concrete form for the walls were made, when the inclemency of the weather necessitated a suspension of operations. In 1895, after removing what remained of the form constructed in the previous season, and a considerable quantity of gravel that had washed into the excavation during the winter, the concrete form for the lock foundation was built in a depth of 30 feet of water, measured from the surface of the Davis Island pool, and filled with concrete of natural hydraulic cement to a height of 22 feet, or within 8 feet of the surface of the Davis Island pool. After laying a concrete floor 2 feet in thickness over the entire area of the lock chamber at the bottom of the excavation, the chamber area and the space between the outer side of the form and the excavated slopes at the side were refilled with river gravel to within 3 feet of the general level of the top of the concrete or 11 feet under the level of the Davis Island pool.

This was practically the status of the work at the beginning of the past fiscal year, except that preparatory to erecting the lock walls the stone for the ends of the buttress walls and miter sills had been cut, the gap in the lower wing of the cofferdam closed, and the pumps, derricks, and other machinery set and fitted up ready for operation. The year throughout was not at all a favorable one for the prosecution of river improvement work in this vicinity, and considerable delay was experienced in making a beginning because of incessant rains, producing in rapid succession rises which kept the cofferdam submerged most of the time. The first attempt to commence work was made on July 13, but barely had the water in the inclosure been lowered to the level of the foundation walls, and the heavy deposits of sediment removed from them when a sudden rise occurred, submerging the entire work. The water receded quickly, and on July 19 the pumps resumed work. When practically the same stage as on the former trial had been reached, there followed, on July 22, another rise, which also in a few hours covered the cofferdam. This rise, however, proved disastrous, in that a serious break occurred in the outer wall of the dam near the head of the inclosure. This portion of the dam, which had been exposed to heavy scour on both sides, had been undermined repeatedly and emptied, and when last refilled had inclined inward at the top about 3 feet from a vertical. The structure being thus materially weakened was tied back to a large protection crib on the outside with a heavy iron rod. Notwithstanding this precaution, however, the excessive pressure of a 9-foot head rapidly approaching the top of the structure, finally caused it to break, and 165 linear feet of the dam was destroyed. Fortunately the disaster had been anticipated and the entire working force taken out of the inclosure and the working plant, which at the time was moored within, amply secured for such an emergency. Consequently no loss was sustained save that to the cofferdam.

Immediately preparations were made for speedily repairing the break. All of the wreckage was secured and the additional new material procured and timber framed. The water did not again reach a working stage until August 14, when the work of restoring the cofferdam was started. In six days the timber work, except the decking, was in place, and two days later the interior filling was completed and the pumps again set to work unwatering the inclosure. Having been allowed no time to settle, the filling material in the newly constructed portion of dam was in a semifluid state and unstable, and hence care was exercised in lowering the water on this occasion as a precaution against weakening the structure. When empty the inclosure disclosed fully 1½ feet of mud deposited over the entire area by the recent freshets. This was removed from the walls as before by applying a powerful jet of water from a section of hose attached to a 4-inch centrifugal pump. Similar deposits of sediment were also found to have occurred in the landing for material boats at the head of the cofferdam, to remove which the services of a steam dredge were secured. During the period of high water a heavy storm also blew down the smokestacks of the steam plant, completely wrecking them and seriously injuring the water and steam lines. New stacks were erected and the pipe line repaired.

On August 28 the foundation walls were ready for the laying of concrete, and a few days were devoted to bringing them up to an even surface at an elevation of 7 feet below the level of the Davis Island Pool for the reception of the lock walls. The wall at the head of the lock chamber, 10 feet in thickness, was also raised to the proposed level of the miter sill, 13 feet under the level of the Herrs Island Pool, and that at the lower end of the chamber to an elevation 2 feet lower. This work was finished on September 3, and the construction of the lock walls commenced. It was deemed advisable to start the river wall first. After permitting the water in the inclosure to rise about 4 feet, the valves in that wall, 8 in number, each 4½ feet in diameter, were placed in position by the derrick boat. The water was then lowered to its former level, the valves set, and the centers for valve openings and culverts built. This completed the preliminary work preparatory to the setting of stone at the ends of the buttresses and the laying of concrete in the wall.

The method employed in the laying of concrete in the walls was exceedingly simple, involving no difficult and expensive construction of form with heavy bracing to hold the same in position during the process of setting of the cement. Building proceeded in 1-foot courses, covering the entire wall. The form was constructed of 2 by 12 inch hemlock planking, 20 feet in length, set on edge, the ends being halved to form 2-inch lap splices. To prevent the form planks from spreading, ½-inch iron tie rods were introduced at intervals of 6 feet 8 inches in such arrangement as to place a rod at each splice. Alongside each tie rod was placed a 2 by 12 inch hemlock spacer, primarily to maintain the uniform thickness of the wall, and secondarily to secure a moderately well-defined vertical seam in the wall at each tie rod. The spacers were so arranged as to place within alternate spaces two of the rods. When an accurate alignment of the lock face of the form had been secured and the spaces containing rods well sprinkled with water, the concrete was placed therein and thoroughly rammed with 20-pound cast-iron rammers. After laying the concrete in these spaces throughout an entire course, the force returned to the original starting point and, after removing the spacers, proceeded to fill the intermediate spaces in the same way, completing the course. As this work of finishing a course progressed, the carpenter force followed closely with the construction of the form for the next course, so that the work of laying concrete went on continuously, no intermission occurring between the completion of one course and the erection of the form for the next succeeding one.

The stone at the ends of the buttress walls were set as the laying of concrete permitted. This stone was dressed during the previous year and stored on the Government lot on the opposite bank of the river. As needed, it was transported to the lock on a shallow boat and transferred to the small concrete scows in the inclosure by a wooden derrick erected on the cofferdam for the purpose. In the scows the stone was conveyed to the lock walls and set with the derrick boat.

The laying of concrete in the lock wall proper on the river side of the lock was commenced on September 8 and continued without interruption until September 23, during which time the wall was raised 8 feet, or to an elevation of 1 foot above the level of the Davis Island Pool. Operations on this wall were then temporarily suspended and attention directed to the lower level of the land wall. The water in the inclosure, which had been permitted to rise as the concrete work progressed, was again lowered to the level of the foundation walls, the valve-opening centers in the river wall removed, and the valves and centers for all openings in the land wall set. This work was completed on September 28, when the laying of concrete began. On September 30 operations were interrupted by a very sudden rise, mainly out of the Monongahela River. This rise was also one of the most rapid of which there is record here, having attained at one time a rate of 22 inches per hour. It required only a short time to submerge the entire work. The maximum stage reached was 13.5 feet above low water, and operations were suspended for one week. When the rise had subsided, work was resumed and not again interrupted until October 14, when the water again rose over the cofferdam, causing a loss of four days. On October 28 the land wall had been built to the height of 15 feet above the foundation level, or 8 feet above the Davis Island Pool. Up to this time the concrete had been run from the mixers directly into the small scows, and from these shoveled into place on the walls. The land wall having reached the limit of cast for shovelers, this method was stopped and preparations made for hoisting the concrete into place with the derrick boat.

This necessitated a complete change in the handling of all materials and the abandonment of the cofferdam in order to run the sand and gravel boats into the cofferdam inclosure within the reach of derrick No. 2. Derrick No. 3, at the head of the cofferdam, which had been used for transferring the sand and gravel tubs from the boats to the tramway conveying same to the mixer bins, was dismantled, and the hoisting engine, with boiler attached, removed to the derrick boat. The small scows were again fitted up for carrying dumping tubs and the river bed under the mixers excavated to a sufficient depth to accommodate them at a low stage of water. While these alterations were in progress the cofferdam inclosure was unwatered for the last time, and all centers and forms in culverts and openings communicating with the river face of the walls removed, and the culvert openings rounded with concrete to the diameter of the valves. A gap 50 feet wide was then cut through the outer wall of the cofferdam, above the head of the lock, and dredged to a depth of 9 feet below the surface of Davis Island Pool, for the passage of material boats. These changes in plant, cofferdam, etc., required two days to complete, and on October 31 the laying of concrete was resumed. On November 17 both walls had been built to within one course, less than 1 foot, of their final height. The next eight days were devoted to laying this top course or coping, which was necessarily tedious, owing to the introduction of a network of forms for the operating machinery for the valves, turbine, and gates, and the setting of snubbing posts, etc. In method of construction the coping differs from the concrete underneath only in that it was laid in one continuous course. It was uniformly rammed to a level surface, the rounded edges shaped with concave hard-wood rammers, and the whole troweled smooth. The walls were completed on November 25, having been under construction three months, the work, however, being performed in sixty-three working days, daylight only being utilized. Throughout the laying of concrete special care was taken to avoid conditions which might serve to its detriment. During hot weather the surfaces of newly laid concrete exposed to the rays of the sun were kept continually moistened to insure proper setting. Also, no concrete was placed during heavy rains, or in freezing weather; and when the conditions favored low temperatures, ample allowance was made for the setting of cement in advance of the freezing point.

The lock walls are 400 feet in length, 9 feet in thickness, increasing to 16 feet at the buttresses, and 20 feet high above the foundation walls, the top elevation being 12 feet above the level of the Davis Island pool. The concrete used in their construction was composed of 1 part Portland cement, 2½ parts sand, and 4½ parts clean washed river gravel, except in the coping and bottom courses, where the cement only was increased 33 per cent. At first the gravel was limited to 2 inches and one-half inch in its larger and smaller diameters respectively, but after a few days' trial it was decided to limit it only in its larger dimension to 1½ inches in diameter. Later, when the walls were about one-half constructed, this dimension was again reduced to 1 inch. In preparing the concrete a minimum proportion of water was used, so that when rammed to its utmost compressibility a showing of moisture on the surface was barely perceptible. From repeated examinations of the work there can be no doubt that an artificial stone of a reasonable density and hardness has been produced. At the same time, there are no visible indications in the exposed faces of the walls of any cracking, swelling, or other defects occasionally developing in concrete work.

Five thousand nine hundred and twenty-four cubic yards of concrete, measured in place, was laid during the season, in which were used 8,195 barrels of cement, or 1.38 barrels cement per cubic yard of concrete. Of the cement, 6,195 barrels were "Atlas" Portland, an American brand, and 2,000 barrels "Josson," a Belgian Portland. These cements were subjected to a system of rigid tests, which they withstood satisfactorily.

Immediately upon the completion of the lock walls the pumping plant was dismantled and removed to the storehouses and as much as possible of the cofferdam taken out for use in constructing cofferdams across the ends of the lock chamber. The wooden derrick on the head wall of the cofferdam was also taken down and stored on the bank. In removing the cofferdam the plank sheeting was drawn by the derrick boat and the condition of all materials preserved for further use. During the month of December the cofferdams at the ends of the lock chamber, each 55 feet long, 12 feet wide, and built to the height of 6 feet above the level of Davis Island pool, were constructed from the materials so recovered, except a small quantity of gravel filling.

On December 29 the 4-inch centrifugal pump was put in position and the unwatering of the lock chamber commenced. It required but a few days to empty the inclosure, indicating the presence of only a small amount of leakage in the walls and floor of the lock. A crib-work foundation for derrick No. 3, which had been removed to the lock, was constructed near the upper miter wall, but further operations were prevented through the inclemency of the weather. However, the water was kept out of the chamber until the rise and general break of the ice on February 6, when it was permitted to flood the inclosure and work was suspended for the winter.

The ice at this time, although very heavy, and the freshet on February 24, which reached the height of 29.5 feet above low water at Pittsburg, resulted in absolutely no injury to the work. Owing to continued high water no attempt to empty the chamber was made until April, when after pumping two days the water again rose, submerging the cofferdam and causing a further delay.

The water having reached a favorable stage, operations were resumed on June 4. After a few days' pumping, in order to drain as much as possible the water retained in the large deposits of sediment, derrick No. 3 was erected within reach of the upper miter sill and the quoin blocks omitted in constructing the lock walls and the excavation for the miter walls commenced. When the excavation had been carried to a depth of 16 feet below the surface of the Davis Island pool, the original concrete foundation laid under water was reached.

* * * * * * *

At the end of the fiscal year the placing of concrete in the foundation for the upper miter sill was in progress at an elevation of 4 feet below the bottom of the sill. Some work had also been accomplished on the setting of the anchorage bolts for the gate cushions. In the construction, etc., of the sills and quoin blocks the concrete and stone are conveyed to the lock in small scows and placed in position by the large iron derrick stationed in the lock chamber. The completion of the miter sills and quoin blocks and the construction of the lock floor are about all that can be done to advantage on the lock until after the dam has been constructed.

Summary of work performed and materials expended during the year.

Cofferdam erected	linear feet..		275
Excavation made:			
Dredging landings and gap in cofferdam	cubic yards..		650
For miter-sill foundations	do....		440
Concrete laid, measurement in place:			
In foundations for lock walls	cubic yards..	533	
In lock walls	do....	5,391	
In miter-sill foundations	do....	171	
			6,095
Valves set (4½ feet diameter)	number..		16
Snubbing posts set	do....		8
Stone set in ends of buttresses	cubic yards..		176
Hemlock lumber:			
In cofferdams	feet B. M..		37,000
In concrete forms	do....		74,000
Gravel and clay filling in cofferdams	cubic yards..		1,470
Gravel in concrete	do....		4,602
Sand in concrete	do....		2,660
Cement	barrels..		8,481

The act of June 3, 1896, provided for commencing construction of locks and dams (Nos. 2 and 3, Allegheny River) above the head of Six Mile Island and at Springdale and authorized their completion under the continuing-contract system.

A general project for the construction was prepared and approved; negotiations made for the lands required for sites for locks and abutments of dams; plans and specifications drawn; the work advertised for bids, and contract entered into.

Part of the needed lands has been acquired by the United States, and it is expected that active operations of construction will be commenced shortly.

These new locks and dams will extend slack water having 6 feet least channel depth from the Herr Island pool 17 miles, or to Natrona.

The dams are to be made of timber and the locks of concrete. The lifts of the locks will be 11 and 12 feet and the depths of water on the lower and upper sills 7 and 8 feet, respectively, at pool levels. The useful dimensions of the lock chambers are to be 56 by 289.5 feet.

Money statement.

July 1, 1896, balance unexpended	$71,511.11
Amount appropriated by sundry civil act approved June 4, 1897	350,000.00
	421,511.11
June 30, 1897, amount expended during fiscal year	55,997.09
July 1, 1897, balance unexpended	365,514.02
July 1, 1897, outstanding liabilities	4,484.41
July 1, 1897, balance available	361,029.61
Amount (estimated) required for completion of existing project	544,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	272,250.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

August 5, 1886	$37,500	June 3, 1896	$50,000
August 11, 1888	35,000	June 4, 1897	350,000
September 19, 1890	35,000		
July 13, 1892	40,000	Total	587,500
August 17, 1894	40,000		

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, opened at 12 m. April 27, 1897, by Maj. Chas. F. Powell, Corps of Engineers.

LOCK NO. 2.

Materials.	Quantities.	No. 1.—Sloan, McIlvain & Ott Bros., Allegheny, Pa.		No. 2.—I. V. Hoag, jr., Pittsburg, Pa.		No. 3.—C. I. McDonald Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing			$13.00		$100.00		$1.00
Excavation:							
Earth, cubic yards	6,366	$0.22	1,400.52	$5.00	31,830.00	$0.50	3,183.00
Hardpan, do	50	.75	37.50	5.00	250.00	.80	40.00
Rock, do	1,883.5	1.75	3,296.13	5.00	9,417.50	1.50	2,825.25
Embankment, do	73,064	.48	35,070.72	.30	21,919.20	.35	25,572.40
Concrete:							
Natural cement, do	3,363	3.59	12,073.17	7.00	23,541.00	4.64	15,604.32
Portland cement, do	12,341	4.99	61,581.59	9.00	111,069.00	6.74	83,178.34
Stone filling in cribs, do	4,063	1.25	5,078.75	2.00	8,126.00	1.25	5,078.75
Stone paving of cribs, square yards	368	1.20	441.60	1.00	368.00	1.90	699.20
Stone paving of river bank, do	6,892	1.50	10,338.00	1.00	6,892.00	1.00	6,892.00
White oak—							
In gates, feet B. M	54,798	47.00	2,575.51	60.00	3,287.88	50.00	2,739.90
Quoins and sills, do	7,950	60.00	477.00	60.00	477.00	50.00	397.50
Cribs, abutment, and spars, do	82,016	44.00	3,608.70	40.00	3,280.64	24.00	1,968.38
Hemlock in cribs, do	113,766	19.50	2,218.44	25.00	2,844.15	18.00	2,047.79
Driftbolts in cribs, pounds	14,600	.017	248.20	.02½	365.00	.03½	511.00
For dam.							
White-oak timber, feet B. M	783,000	30.00	23,490.00	40.00	31,320.00	24.40	19,105.20
Hemlock timber, do	658,700	19.50	12,844.65	25.00	16,467.50	17.75	11,691.93
White-oak sheeting on back of dam, feet B. M	74,100	28.00	2,074.80	40.00	2,964.00	21.50	1,593.15
Riprap stone filling, cubic yards	22,120	1.00	22,120.00	2.00	44,240.00	1.19	26,322.80
Driftbolts, pounds	176,100	.017	2,993.70	.02½	4,402.50	.03½	6,163.50
Dredging foundation, cubic yards	54,300	.17	9,231.00	.10	5,430.00	.25	13,575.00
Refilling for dam, do	33,800	.16	5,408.00	.10	3,380.00	.23	7,774.00
Backing of dam, do	6,100	.15	915.00	.10	610.00	.23	1,403.00
Hemlock piles, in place	95	4.32	410.40	10.00	950.00	9.00	855.00
Hemlock sheeting and scantling in foundation, feet B. M	159,144	16.00	2,546.30	50.00	7,957.20	25.00	3,978.60
Total			220,492.68		341,488.57		243,201.01
To pay for use of United States plant			500.00		3,010.50		500.00
Samples:							
Sand		Poor		Fair		Poor.	
Gravel		Excellent		Good		Excellent.	

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCK NO. 2—Continued.

Materials.	Quantities.	No. 4.—McArthur Brothers Co., Chicago, Ill.		No. 5.—The Barnett & Record Co., Minneapolis, Minn.		No. 6.—The T. A. Gillespie Co., Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing			$1,200.00		$500.00		$100.00
Excavation:							
Earth .... cubic yards	6,366	$1.30	8,275.80	$4.80	30,556.80	$0.50	3,183.00
Hardpan .... do	50	1.00	50.00	5.30	265.00	1.25	62.50
Rock .... do	1,883.5	5.00	9,417.50	5.40	10,170.90	1.50	2,825.25
Embankment .... do	73,064	.54	39,454.56	.55	40,185.20	.35	25,572.40
Concrete:							
Natural cement .... do	3,363	5.30	17,823.90	7.60	25,558.80	6.00	20,178.00
Portland cement .... do	12,341	6.50	80,216.50	9.70	119,707.70	7.50	92,557.50
Stone filling in cribs .... do	4,063	1.40	5,688.20	1.40	5,688.20	1.75	7,110.25
Stone paving of cribs .. square yards	368	1.50	552.00	1.90	699.20	2.00	736.00
Stone paving of river bank .... do	6,892	1.50	10,338.00	2.00	13,784.00	2.00	13,784.00
White oak—							
In gates .... feet B. M	54,798	75.00	4,109.85	57.00	3,123.49	66.00	3,616.67
Quoins and sills .... do	7,950	85.00	675.75	90.00	715.50	66.00	524.70
Cribs, abutment, and spars. do	82,016	31.00	2,542.50	37.00	3,034.59	40.00	3,280.64
Hemlock in cribs .... do	113,766	22.00	2,502.85	20.50	2,332.20	25.00	2,844.15
Driftbolts in cribs .... pounds	14,600	.04	584.00	.05	730.00	.02½	365.00
For dam.							
White-oak timber .... feet B. M	783,000	32.00	25,056.00	37.00	28,971.00	55.00	43,065.00
Hemlock timber .... do	658,700	24.00	15,808.80	21.00	13,832.70	35.00	23,054.50
White-oak sheeting on back of dam, feet B. M	74,100	42.00	3,112.20	36.00	2,667.60	45.00	3,334.50
Riprap stone filling ..... cubic yards	22,120	1.40	30,968.00	1.90	42,028.00	2.00	44,240.00
Driftbolts .... pounds	176,100	.04	7,044.00	.05	8,805.00	.02½	4,402.50
Dredging foundation ... cubic yards	54,300	.20	10,860.00	1.75	95,025.00	.20	10,860.00
Refilling for dam .... do	33,800	.20	6,760.00	.42	14,196.00	.15	5,070.00
Backing of dam .... do	6,100	.30	1,830.00	1.10	6,710.00	.30	1,830.00
Hemlock piles, in place	95	8.00	760.00	10.00	950.00	12.00	1,140.00
Hemlock sheeting and scantling in foundation .... feet B. M	159,144	50.00	7,957.20	25.00	3,978.00	40.00	6,365.76
Total			293,687.61		474,215.48		320,102.32
To pay for use of United States plant			1,500.00		2,000.00		500.00
Samples:							
Sand		Good		Poor		Good.	
Gravel		Excellent		Excellent		Excellent.	

Materials.	Quantities.	No. 7.—Wm. B. Rodgers, Pittsburg, Pa.		No. 8.—Jas. McCarron, Philadelphia, Pa.		No. 10.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing			$100.00		$250.00		$200.00
Excavation:							
Earth .... cubic yards	6,366	$0.49	3,119.34	$0.15	954.90	$0.50	3,183.00
Hardpan .... do	50	.90	45.00	.20	10.00	1.00	50.00
Rock .... do	1,883.5	1.35	2,542.73	3.00	5,650.50	2.00	3,767.00
Embankment .... do	73,064	.45	32,878.80	.15	10,959.60	.50	36,532.00
Concrete:							
Natural cement .... do	3,363	4.75	15,974.25	3.59	12,073.17	6.00	20,178.00
Portland cement .... do	12,341	5.79	71,454.39	5.74	70,837.34	8.00	98,728.00
Stone filling in cribs .... do	4,063	2.40	9,751.20	1.59	6,460.17	2.25	9,141.75
Stone paving of cribs .. square yards	368	1.49	548.32	3.00	1,104.00	2.50	920.00
Stone paving of river bank .... do	6,892	1.49	10,269.08	3.00	20,676.00	2.50	17,230.00
White oak—							
In gates .... feet B. M	54,798	39.00	2,137.12	40.00	2,191.92	100.00	5,479.80
Quoins and sills .... do	7,950	39.09	810.05	40.00	318,00	100.00	795.00
Cribs, abutment, and spars. do	82,016	31.90	2,616.31	35.00	2,870.56	30.00	2,460.48
Hemlock in cribs .... do	113,766	22.90	2,605.24	23.00	2,616.62	20.00	2,275.32
Driftbolts in cribs .... pounds	14,600	.019	277.40	.02¼	328.50	.04	584.00

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCK NO. 2—Continued.

Materials.	Quantities.	No. 7.—Wm. B. Rodgers, Pittsburg, Pa.		No. 8.—Jas. McCarron, Philadelphia, Pa.		No. 10.—Jacob Friday & Sons, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For dam.							
White-oak timber..........feet B. M..	783,000	$36.50	$28,579.50	$35.00	$27,405.00	$30.00	$23,490.00
Hemlock timber ....do....	658,700	26.50	17,455.55	23.00	15,150.10	20.00	13,174.00
White-oak sheeting on back of dam, feet B. M	74,100	36.50	2,704.65	35.50	2,630.55	38.00	2,815.80
Riprap stone filling.....cubic yards..	22,120	2.40	53,088.00	1.59	35,170.80	2.25	49,770.00
Driftbolts...................pounds..	176,100	.019	3,345.90	.02¼	3,962.25	.04	7,044.00
Dredging foundation...cubic yards..	54,300	.29	15,747.00	.25	13,575.00	.50	27,150.00
Refilling for dam................do....	33,800	.29	9,802.00	.15	5,070.00	.30	10,140.00
Backing of dam.................do....	6,100	.43	2,623.00	.15	915.00	.30	1,830.00
Hemlock piles, in place..............	95	8.10	769.50	4.00	380.00	10.00	950.00
Hemlock sheeting and scantling in foundation..............feet B. M..	159,144	31.90	5,076.69	23.00	3,660.31	30.00	4,774.32
Total..................................	....	....	293,821.02	....	245,220.29	....	342,662.47
To pay for use of United States plant.	....	....	1,000.00	....	1,000.00	....	2,000.00
Samples:							
Sand	....	Good		Poor		No samples.	
Gravel	....	.....do............		No sample.......			

Materials.	Quantities.	No. 12.—McLean, Kaufman & Co., Pittsburg, Pa., New York, N. Y.		No. 13.—Hulings Bros., Pittsburg, Pa.		No. 14.—Keeling & Ridge, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing................	....	....	$50.00	....	$1,000.00	....	$10.00
Excavation:							
Earth...............cubic yards..	6,366	$0.25	1,591.50	$1.00	6,366.00	$0.40	2,546.40
Hardpan ....do....	50	.40	20.00	2.00	100.00	1.00	50.00
Rock.........................do....	1,883.5	1.00	1,883.50	2.00	3,767.00	2.50	4,708.75
Embankment ....do....	73,064	.20	14,612 80	1.00	73,064.00	.75	54,798.00
Concrete:							
Natural cement............do....	3,363	4.66	15,671.58	7.00	23,541.00	6.00	20,178.00
Portland cement ....do....	12,341	6.45	79,599.45	10.00	123,410.00	8.25	101,813.25
Stone filling in cribs............do....	4,063	2.20	8,938.60	2.50	10,157.50	2.00	8,126.00
Stone paving of cribs..square yards..	368	2.00	736.00	3.00	1,104.00	1.50	552.00
Stone paving of river bank....do....	6,892	2.00	13,784.00	3.00	20,676.00	1.50	10,338.00
White oak—							
In gates...............feet B. M..	54,798	50.00	2,739.90	75.00	4,109.85	60.00	3,287.88
Quoins and sills............do....	7,950	50.00	397.50	75.00	596.25	40.00	318.00
Cribs, abutment, and spars.do....	82,016	28.00	2,296.45	60.00	4,920.96	33.00	2,706.53
Hemlock in cribs...............do....	113,766	22.00	2,502.85	40.00	4,550.64	20.00	2,275.32
Driftbolts in cribs...........pounds..	14,600	.02½	365.00	.03	438.00	.04	584.00
For dam.							
White-oak timber..........feet B. M..	783,000	28.00	21,924.00	60.00	46,980.00	35.00	27,405.00
Hemlock timber ....do....	658,700	22.00	14,491.40	40.00	26,348.00	25.00	16,467.50
White-oak sheeting on back of dam, feet B. M	74,100	35.00	2,593.50	75.00	5,557.50	25.00	1,852.50
Riprap stone filling.....cubic yards..	22,120	2.20	48,664.00	3.50	77,420.00	2.00	44,240.00
Driftbolts...................pounds..	176,100	.02½	4,402.50	.03	5,283.00	.04	7,044.00
Dredging foundation...cubic yards..	54,300	.30	16,290.00	1.00	54,300.00	.35	19,005.00
Refilling for dam................do....	33,800	.30	10,140.00	1.00	33,800.00	.35	11,830.00
Backing of dam.................do....	6,100	.30	1,830.00	1.25	7,625.00	.35	2,135.00
Hemlock piles, in place..............	95	6.00	570.00	10.00	950.00	10.00	950.00
Hemlock sheeting and scantling in foundation..............feet B. M..	159,144	40.00	6,365.76	75.00	11,935.80	15.00	2,387.16
Total..................................	....	....	272,460.29	....	548,000.50	....	345,608.29
To pay for use of United States plant.	....	....	3,500.00	....	1,450.00	....	....
Samples:							
Sand	....	Good		Excellent		Good.	
Gravel	....	Excellent		Fair..............		Poor.	

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCK NO. 3.

Materials.	Quantities.	No. 1.—Sloan, McIlvain & Ott Bros., Allegheny, Pa.		No. 2.—I. V. Hoag, jr., Pittsburg, Pa.		No. 3.—C. I. McDonald, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing			$142.00		$1.00		$1.00
Excavation:							
Earth ... cubic yards	28,510	$0.12	3,421.20	$2.85	81,253.50	$0.40	11,404.00
Hardpan ... do	50	.75	37.50	2.85	142.50	.80	40.00
Rock ... do	1,120	1.75	1,960.00	2.85	3,192.00	1.75	1,960.00
Embankment ... do	6,422	2.19	14,064.18	.30	1,926.60	.35	2,247.70
Concrete:							
Natural cement ... do	3,902	4.18	16,310.36	7.00	27,314.00	4.64	18,105.28
Portland cement ... do	11,407	5.57	63,536.99	9.00	102,663.00	6.74	76,883.18
Stone filling in cribs ... do	5,942	1.00	5,942.00	2.00	11,884.00	1.25	7,427.50
Stone paving—							
Of cribs ... square yards	423	1.10	465.30	1.00	423.00	1.90	803.70
Of river bank ... do	1,593	1.40	2,230.20	1.00	1,593.00	1.00	1,593.00
White oak—							
In gates ... feet B. M	54,798	47.00	2,575.51	60.00	3,287.88	50.00	2,739.90
Quoins and sills ... do	7,950	60.00	477.00	60.00	477.00	50.00	397.50
Cribs, abutment, and spars ... do	60,670	44.00	2,669.48	40.00	2,426.80	24.00	1,456.08
Hemlock in cribs ... do	79,150	19.50	1,543.43	25.00	1,978.75	18.00	1,424.70
Driftbolts in cribs ... pounds	10,620	.017	180.54	.02½	265.50	.03½	371.70
For dam.							
White-oak timber ... feet B. M	530,484	30.00	15,914.52	40.00	21,219.36	24.40	12,943.81
Hemlock timber ... do	465,618	19.50	9,079.55	25.00	11,640.45	17.75	8,264.72
White-oak sheeting on back of dam, feet B. M	59,365	28.00	1,662.22	40.00	2,374.60	21.50	1,276.35
Riprap stone filling ... cubic yards	17,714	1.07	18,953.98	2.00	35,428.00	1.14	20,193.96
Driftbolts ... pounds	141,038	.017	2,397.65	.02½	3,525.95	.03½	4,936.33
Dredging foundation ... cubic yards	34,430	.16	5,508.80	.10	3,443.00	.25	8,607.50
Refilling for dam ... do	27,180	.15	4,077.00	.10	2,718.00	.23	6,251.40
Backing of dam ... do	4,880	.15	732.00	.10	488.00	.23	1,122.40
Hemlock piles, in place	77	4.32	332.64	10.00	770.00	10.00	770.00
Hemlock sheeting and scantling in foundation ... feet B. M	107,373	16.00	1,717.97	50.00	5,368.65	24.00	2,576.95
Total			175,932.02		325,804.54		198,798.66
To pay for use of United States plant			500.00		3,010.50		500.00
Samples:							
Sand		Poor		Fair		Poor.	
Gravel		Excellent		Good		Excellent.	

Materials.	Quantities.	No. 4.—McArthur Bros.' Co., Chicago, Ill.		No. 6.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 7.—Wm. B. Rodgers, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing			$1,200.00		$100.00		$100.00
Excavation:							
Earth ... cubic yards	28,510	$0.60	17,106.00	$0.50	14,255.00	$0.65	18,531.50
Hardpan ... do	50	1.00	50.00	1.25	62.50	.90	45.00
Rock ... do	1,120	6.00	6,720.00	1.50	1,680.00	1.35	1,512.00
Embankment ... do	6,422	.60	3,853.20	.35	2,247.70	.45	2,889.90
Concrete:							
Natural cement ... do	3,902	5.50	21,461.00	6.00	23,412.00	4.75	18,534.50
Portland cement ... do	11,407	6.50	74,145.50	7.50	85,552.50	5.79	66,046.53
Stone filling in cribs ... do	5,942	1.30	7,724.60	1.75	10,398.50	2.40	14,260.80
Stone paving—							
Of cribs ... square yards	423	1.50	634.50	2.00	846.00	1.49	630.27
Of river bank ... do	1,593	1.50	2,389.50	2.00	3,186.00	1.49	2,373.57
White oak—							
In gates ... feet B. M	54,798	75.00	4,109.85	66.00	3,616.67	39.00	2,137.12
Quoins and sills ... do	7,950	85.00	675.75	66.00	524.70	39.00	310.05
Cribs, abutment, and spars ... do	60,670	31.00	1,880.77	40.00	2,426.80	31.90	1,935.37
Hemlock in cribs ... do	79,150	22.00	1,741.30	25.00	1,978.75	22.90	1,812.54
Driftbolts in cribs ... pounds	10,620	.04	424.80	.02½	265.50	.019	201.78

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCK NO. 3—Continued.

Materials.	Quantities.	No. 4.—McArthur Bros.' Co., Chicago, Ill.		No. 6.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 7.—Wm. B. Rodgers, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For dam.							
White-oak timber..........feet B. M..	$530,484	$32.00	$16,975.49	$55.00	$29,176.62	$36.50	$19,362.67
Hemlock timber..................do..	465,618	24.00	11,174.83	35.00	16,296.63	26.50	12,338.88
White-oak sheeting on back of dam, feet B. M....................	59,365	42.00	2,493.33	45.00	2,671.43	36.50	2,166.82
Riprap stone filling.....cubic yards..	17,714	1.40	24,799.60	2.00	35,428.00	2.40	42,513.60
Driftbolts....................pounds..	141,038	.04	5,641.52	.02½	3,525.95	.019	2,679.72
Dredging foundation...cubic yards..	34,430	.20	6,886.00	.20	6,886.00	.29	9,984.70
Refilling for dam..................do..	27,180	.20	5,436.00	.15	4,077.00	.29	7,882.20
Backing of dam..................do..	4,880	.30	1,464.00	.30	1,464.00	.43	2,098.40
Hemlock piles, in place..................	77	8.00	616.00	12.00	924.00	8.10	623.70
Hemlock sheeting and scantling in foundation..............feet B. M..	107,373	50.00	5,368.65	40.00	4,294.92	31.90	3,425.20
Total....................................	....	....	224,972.19	....	255,297.17	....	234,396.82
To pay for use of United States plant.	....	....	1,500.00	....	500.00	....	1,000.00
Samples:							
Sand....................................	....	Good.............		Good.............		Good.	
Gravel....................................	....	Excellent		Excellent		Do.	

Materials.	Quantities.	No. 8.—Jas. McCarron, Philadelphia, Pa.		No. 10.—Jacob Friday & Sons, Pittsburg, Pa.		No. 12.—McLean, Kaufman & Co., Pittsburg, Pa., New York, N. Y.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For lock and abutment.							
Grubbing and clearing..................	....	....	$250.00	....	$200.00	....	$50.00
Excavation:							
Earth...............cubic yards..	28,510	$0.15	4,276.50	$0.50	14,255.00	$0.25	7,127.50
Hardpan....................do....	50	.20	10.00	1.00	50.00	.40	20.00
Rock........................do....	1,120	3.00	3,360.00	2.00	2,240.00	1.00	1,120.00
Embankment...................do....	6,422	.15	963.30	.50	3,211.00	.20	1,284.40
Concrete:							
Natural cement.............do....	3,902	3.59	14,008.18	6.00	23,412.00	4.66	18,183.32
Portland cement...........do....	11,407	5.74	65,476.18	8.00	91,256.00	6.45	73,575.15
Stone filling in cribs............do....	5,942	1.59	9,447.78	2.00	11,884.00	2.20	13,072.40
Stone paving—							
Of cribs............square yards..	423	3.00	1,269.00	2.25	951.75	2.00	846.00
Of river bank...............do....	1,593	3.00	4,779.00	2.25	3,584.25	2.00	3,186.00
White oak—							
In gates................feet B. M..	54,798	40.00	2,191.92	100.00	5,479.80	50.00	2,739.90
Quoins and sills.............do....	7,950	40.00	318.00	100.00	795.00	50.00	397.50
Cribs, abutment, and spars.do....	60,670	35.00	2,123.45	30.00	1,820.10	28.00	1,698.76
Hemlock in cribs...............do....	79,150	23.00	1,820.45	20.00	1,583.00	22.00	1,741.30
Driftbolts in cribs............pounds..	10,620	.02¼	238.95	.04	424.80	.02½	265.50
For dam.							
White-oak timber..........feet B. M..	530,484	35.00	18,566.94	30.00	15,914.52	28.00	14,853.55
Hemlock timber................do...	465,618	23.00	10,709.21	20.00	9,312.36	22.00	10,243.60
White oak sheeting on back of dam, feet B. M....................	59,365	35.50	2,107.46	38.00	2,255.87	35.00	2,077.78
Riprap stone filling.....cubic yards..	17,714	1.59	28,165.26	2.00	35,428.00	2.20	38,970.80
Driftbolts....................pounds..	141,038	.02¼	3,173.36	.04	5,641.52	.02½	3,525.95
Dredging foundation ...cubic yards..	34,430	.25	8,607.50	.50	17,215.00	.30	10,329.00
Refilling for dam................do....	27,180	.15	4,077.00	.30	8,154.00	.30	8,154.00
Backing of dam.................do....	4,880	.15	732.00	.30	1,464.00	.30	1,464.00
Hemlock piles, in place..................	77	4.00	308.00	10.00	770.00	6.00	462.00
Hemlock sheeting and scantling in foundation..............feet B. M..	107,373	23.00	2,469.58	30.00	3,221.19	40.00	4,294.92
Total....................................	....	....	189,449.02	....	260,523.16	....	219,683.33
To pay for use of United States plant.	....	....	1,000.00	....	2,000.00	....	3,500.00
Samples:							
Sand....................................	....	Poor.............		No samples......		Good.	
Gravel....................................	....	No sample.......				Excellent.	

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCK NO. 3—Continued.

Materials.	Quantities.	No. 13.—Hulings Bros., Pittsburg, Pa.		No. 14.—Keeling & Ridge, Pittsburg, Pa.	
		Rate.	Amount.	Rate.	Amount.
For lock and abutment.					
Grubbing and clearing			$500.00		$100.00
Excavation:					
Earth … cubic yards	28,510	$0.66	18,816.60	$0.40	11,404.00
Hardpan … do	50	1.35	67.50	1.00	50.00
Rock … do	1,120	1.65	1,848.00	2.50	2,800.00
Embankment … do	6,422	.65	4,174.30	.75	4,816.50
Concrete:					
Natural cement … do	3,902	5.05	19,705.10	6.00	23,412.00
Portland cement … do	11,407	7.45	84,982.15	8.50	96,959.50
Stone filling in cribs … do	5,942	1.65	9,804.30	2.50	14,855.00
Stone paving—					
Of cribs … square yards	423	2.75	1,162.25	1.50	634.50
Of river bank … do	1,593	2.30	3,663.90	1.50	2,389.50
White oak—					
In gates … feet B. M	54,798	65.00	3,561.87	70.00	3,835.86
Quoins and sills … do	7,950	65.00	516.75	45.00	357.75
Cribs, abutment, and spars … do	60,670	40.00	2,426.80	35.00	2,123.45
Hemlock in cribs … do	79,150	28.00	2,216.20	20.00	1,583.00
Driftbolts in cribs … pounds	10,620	.03	318.60	.04	424.80
For dam.					
White-oak timber … feet B. M	530,484	47.00	24,932.75	35.00	18,566.94
Hemlock timber … do	465,618	30.00	13,968.54	25.00	11,640.45
White-oak sheeting on back of dam … do	59,365	52.00	3,086.98	25.00	1,484.13
Riprap stone filling … cubic yards	17,714	2.00	35,428.00	2.50	44,285.00
Driftbolts … pounds	141,038	.03	4,231.14	.04	5,641.52
Dredging, foundation … cubic yards	34,430	.28	9,640.40	.35	12,050.50
Refilling for dam … do	27,180	.28	7,610.40	.35	9,513.00
Backing of dam … do	4,880	.40	1,952.00	.35	1,708.00
Hemlock piles, in place	77	5.00	385.00	10.00	770.00
Hemlock sheeting and scantling in foundation, feet B. M	107,373	54.00	5,798.14	15.00	1,610.60
Total			260,798.67		273,016.00
To pay for use of United States plant			1,450.00		
Samples:					
Sand		Excellent		Good.	
Gravel		Fair		Poor.	

LOCKS AND DAMS 2 AND 3—ONE PROPOSAL.

Material.	Quantities.	No. 6.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 9.—Michael J. Fenton, New York, N.Y.		No. 11.—Heldmaier & Neu, Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For locks and abutments.							
Grubbing and clearing			$100.00				$100.00
Excavation:							
Earth … cubic yards	34,876	$0.50	17,438.00	$0.50	$17,438.00	$0.45	15,694.20
Hardpan … do	100	1.25	125.00	1.00	100.00	.90	90.00
Rock … do	3,003½	1.50	4,505.25	4.00	12,014.00	1.10	3,303.85
Embankment … do	79,486	0.35	27,820.10	.25	19,871.50	.30	23,845.80
Concrete:							
Natural cement … do	7,265	6.00	43,590.00	5.00	36,325.00	3.75	27,243.75
Portland cement … do	23,748	7.50	178,110.00	8.25	195,921.00	6.30	149,612.40
Stone filling in cribs … do	10,005	1.75	17,508.75	2.75	27,518.75	.95	9,504.75
Stone paving—							
Of cribs … square yards	791	2.00	1,582.00	2.75	2,175.25	3.05	2,412.55
Of river bank … do	8,485	2.00	16,970.00	1.50	12,727.50	2.50	21,212.50
White oak—							
In gates … feet B. M	109,596	66.00	7,233.34	60.00	6,575.76	34.50	3,781.06
Quoins and sills … do	15,900	66.00	1,049.40	120.00	1,908.00	42.50	675.75
Cribs, abutments, and spars, feet B. M	142,686	40.00	5,707.44	40.00	5,707.44	24.00	3,424.46
Hemlock in cribs … feet B. M	192,916	25.00	4,822.90	20.00	3,858.32	16.75	3,231.34
Driftbolts in cribs … pounds	25,220	.02½	630.50	.03	756.60	.03	756.60

Abstract of proposals for building locks and dams Nos. 2 (Six Mile Island) and 3 (Springdale) in the Allegheny River, etc.—Continued.

LOCKS AND DAMS 2 AND 3—ONE PROPOSAL—Continued.

Material.	Quantities.	No. 6.—The T. A. Gillespie Co., Pittsburg, Pa.		No. 9.—Michael J. Fenton, New York, N. Y.		No. 11.—Heldmaier & Neu, Chicago, Ill.	
		Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
For dams.							
White-oak timber........feet B. M..	1,313,484	$55.00	$72,241.62	$35.00	$45,971.94	$25.00	$32,837.10
Hemlock timber..............do....	1,124,318	35.00	39,351.13	25.00	28,107.95	16.75	18,832.33
White-oak sheeting on back of dam feet B. M............................	133,465	45.00	6,005.93	40.00	5,338.60	27.00	3,603.56
Riprap stone filling....cubic yards..	39,834	2.00	79,668.00	2.00	79,668.00	.90	35,850.60
Drift bolts.................pounds..	317,138	.02½	7,928.45	.03	9,514.14	.03	9,514.14
Dredging, foundation..cubic yards..	88,730	.20	17,746.00	.25	22,182.50	.18	15,971.40
Refilling for dam..............do....	60,980	.15	9,147.00	.15	9,147.00	.12½	7,622.50
Backing of dam................do....	10,980	.30	3,294.00	.15	1,647.00	.20	2,196.00
Hemlock piles, in place..............	172	12.00	2,064.00	3.00	516.00	18.00	3,096.00
Hemlock sheeting and scantling in foundation.............feet B. M..	266,517	40.00	10,660.68	22.00	5,863.37	45.00	11,993.27
Total................................	....	....	575,299.49	....	550,848.62	....	406,405.91
To pay for use of United States plant.	....	....	500.00	....	....	....	1,000.00
Samples:							
Sand	....	Good............		No samples.....		Poor.	
Gravel	....	Excellent				Fair.	

SUMMARY OF ITEMIZED ABSTRACT.

		No. 2.	No. 3.	Locks and dams Nos. 2 and 3 (one proposal).	Samples.	
					Sand.	Gravel.
1	Sloan, McIlvain & Ott Bros., Allegheny, Pa	$220,492.68	$175,982.02	....	Poor	Excellent.
2	I. V. Hoag, jr., Pittsburg, Pa	341,488.57	325,804.54	....	Fair	Good.
3	C. I. McDonald, Pittsburg, Pa	243,201.01	193,798.66	....	Poor	Excellent.
4	McArthur Brothers Co., Chicago, Ill	293,637.61	224,972.19	....	Good	Do.
5	The Barnett & Record Co., Minneapolis, Minn	474,215.48	....	....	Poor......	Do.
6	The T. A. Gillespie Co., Pittsburg, Pa	320,102.32	255,297.17	$575,299.49	Good	Do.
7	Wm. B. Rodgers, Pittsburg, Pa	293,821.02	234,896.82	....	.....do	Good.
8	Jas. McCarron, Philadelphia, Pa	245,220.29	189,449.02	....	Poor......	No sample.
9	Michael J. Fenton, New York, N. Y	....	....	550,848.62	No sample	Do.
10	Jacob Friday & Sons, Pittsburg, Pa	342,662.47	260,523.16	....	.....do	Do.
11	Heldmaier & Neu, Chicago, Ill	....	....	406,405.91	Poor......	Fair.
12	McLean, Kaufman & Co., Pittsburg, Pa., and New York, N. Y	272,460.29	219,683.33	....	Good	Excellent.
13	Hulings Bros., Pittsburg, Pa	548,000.50	260,798.67	....	Excellent.	Fair.
14	Keeling & Ridge, Pittsburg, Pa	345,608.29	273,016.00	....	Good	Poor.

NOTE.—Samples rated according to quality as poor, fair, good or excellent, for comparison.

Contract in force.

No.	Name of contractor.	For.	Date of approval.	Beginning work.	Expiration.
1	Atlas Cement Co	Portland cement	May 15, 1896	May 15, 1896	Sept. 25, 1896

COMMERCIAL STATISTICS.

The reports of the river's commerce for the last calendar year show it to be about 2,138,000 tons, and that the part above Pittsburg Harbor has increased 23 per cent, and the part within Pittsburg Harbor, 78 per cent since 1892. For full statement of statistics, see report upon improvement of Allegheny River.

APPENDIX E E.

IMPROVEMENT OF FALLS OF THE OHIO RIVER, OF WABASH RIVER, INDIANA AND ILLINOIS, OF WHITE RIVER, INDIANA, AND OF CERTAIN RIVERS IN KENTUCKY.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Falls of the Ohio River at Louisville, Kentucky.
2. Operating and care of Louisville and Portland Canal, Kentucky.
3. Wabash River, Indiana and Illinois.
4. Operating and care of lock and dam at Grand Rapids, Wabash River.
5. White River, Indiana.
6. Tradewater River, Kentucky.
7. Lock No. 2, Green River, at Rumsey, Kentucky.
8. Green River, above mouth of Big Barren River, Kentucky.
9. Operating and care of locks and dams on Green and Barren rivers, Kentucky.
10. Rough River, Kentucky.

EXAMINATION.

11. Treadwater (Tradewater) River, Kentucky.

SURVEYS.

12. White River, Indiana.
13. Green River, Kentucky.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., July 21, 1897.

GENERAL: I have the honor to transmit herewith annual reports for the works under my charge at the close of the fiscal year ending June 30, 1897.

* * * * * * *

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

E E 1.

IMPROVEMENT OF FALLS OF OHIO RIVER AT LOUISVILLE, KENTUCKY.

Operations on this work were suspended throughout the year, with the exception of office work and caring for property, until June 10, 1896, when a small force was set to work repairing breaks in the guiding dike at the easterly end of the Louisville and Portland Canal. Repairs to one of the openings 101 feet long were completed June 16, 1897, and another, 152 feet long, was completed, excepting the top ties and partial stone filling, June 23, 1897, on which date the water reached a stage too high for further work and remained so until the end of the fiscal year.

The sundry civil act of July 4, 1897, contains the following item:

> Improving Falls of Ohio River at Louisville, Kentucky: For continuing improvement, including Indiana Chute Falls, three hundred and fifty thousand dollars: *Provided,* That the Secretary of War may carry to completion the present project of improving the Falls of the Ohio River and Indiana Chute Falls, Ohio River, by contract, as provided in the "Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," which became a law June third, eighteen hundred and ninety-six; or the necessary materials may be purchased and the work done otherwise than by contract, in his discretion, if more economical and advantageous to the United States.

A plan for the application of these funds under the approved projects has been submitted, but has not yet received definite approval.

Inasmuch as the funds now available are applicable to work under both the project for improvement at the head of the Louisville and Portland Canal and that for the improvement of Indiana Chute channel, and as both projects have the same general effect, namely, the improvement of the Falls of the Ohio, it was recommended, under date of June 24, 1897, that the rendition of separate money statements, reports, and statements of outstanding liabilities be discontinued and that a single report combining all the elements of the two reports be hereafter submitted. This recommendation was approved by the Chief of Egineers, United States Army, under date of June 28, 1897, E. D. file mark 21608.

Following is the statement of expenditures, balances, etc., to the close of the fiscal year, and which are combined with those pertaining to Indiana Chute to make the regular money statement given at the end of report concerning Indiana Chute:

July 1, 1896, balance unexpended	$11,617.81
June 30, 1897, amount expended during fiscal year	2,729.04
July 1, 1897, balance unexpended	8,888.77
July 1, 1897, outstanding liabilities	551.02
July 1, 1897, balance available	8,337.75
Amount (estimated) required for completion of project	130,008.89

Full report of project for this work will be found on page 2221, Report of Chief of Engineers, United States Army, for fiscal year ending June 30, 1896.

IMPROVEMENT OF INDIANA CHUTE, FALLS OF THE OHIO RIVER.

No operations were in progress during the year on account of lack of funds. Expenditures during the year were for care of property and office expenses.

For full report of project for this work, see page 2224, Report of Chief of Engineers, United States Army, for fiscal year ending June 30, 1896.

The combination of future reports concerning this work with that for improvements at the head of the Louisville and Portland Canal is referred to in report for improvement of the Falls of Ohio River at Louisville, Ky., and following is a statement of amounts of balances, liabilities, etc., combined with the statement given under the latter heading to make up the money statement at the end of this report:

July 1, 1896, balance unexpended	$1,601.52
June 30, 1897, amount expended during fiscal year	1,254.13
July 1, 1897, balance unexpended	347.39
July 1, 1897, outstanding liabilities	114.96
July 1, 1897, balance available	232.43
Amount (estimated) required for completion of existing project	111,938.71

Money statement.

July 1, 1896, balance unexpended	$13,219.33
Amount appropriated by sundry civil act approved June 4, 1897	350,000.00
	363,219.33
June 30, 1897, amount expended during fiscal year	3,983.17
July 1, 1897, balance unexpended	359,236.16
July 1, 1897, outstanding liabilities	665.98
July 1, 1897, balance available	358,570.18
Amount (estimated) required for completion of existing project	241,947.60
Amount that can be profitably expended in fiscal year ending June 30, 1899	241,947.60

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

NOTE.—The amounts in the foregoing statement are the sums of similar items mentioned in the two reports preceding, together with the amount appropriated by the sundry civil act of June 4, 1897.

Allotments for Indiana Chute from appropriations for improving Ohio River.

July 14, 1880	$10,000.00
March 3, 1881	50,000.00
August 2, 1882	35,000.00
July 5, 1884	10,000.00
August 5, 1886	20,000.00
August 11, 1888	15,000.00
Total	140,000.00

Appropriations for work on Indiana Chute.

September 19, 1890	$25,000.00
July 13, 1892	35,000.00
August 17, 1894	20,000.00
Total	80,000.00

Appropriations for improving Falls of Ohio River, at Louisville, Ky. (Enlargement at head of canal and of basin at locks.)

July 5, 1884	$300,000.00
August 5, 1886	150,000.00
August 11, 1888	150,000.00
September 19, 1890	60,000.00
July 13, 1892	60,000.00
August 17, 1894	60,000.00
Total	780,000.00

Appropriations for improving the Falls of Ohio River and Indiana Chute Falls, Ohio River.

June 3, 1896	$10,000.00
June 4, 1897	350,000.00
Total	360,000.00

For commercial statistics see report for operating and care of Louisville and Portland Canal.

E E 2.

OPERATING AND CARE OF LOUISVILLE AND PORTLAND CANAL, KENTUCKY.

The project and estimate for operations connected with this canal during the fiscal year ending June 30, 1897, contained the following items:

Regular force	$39,600.00
Extra labor	5,000.00
General repairs	6,500.00
Miscellaneous, fuel, oil, etc	8,000.00
Excavating channel below locks	3,626.36
Completing new lower gates, new locks	4,823.43
Completing new upper gates, new locks	2,481.85
Retaining wall, dry dock	14,432.55
Retaining wall to replace rubble wall	11,658.30
Retaining wall in front of unprotected bank	30,856.09
Automatic gates, old locks	7,936.98
New gates for dry dock	5,000.00
Contingencies	6,000.00
Total	145,915.56

The first four items provide for regular employees for operating the locks, the towboat and dredge crews, the shop employees, and the ordinary miscellaneous repairs and supplies. The remaining items provide for repairs of a definite character and of sufficient magnitude to be considered separately.

ORDINARY DAILY OPERATIONS.

During the year the canal was open to navigation three hundred and three days and closed on account of ice and high water sixty-two days, divided as follows: On account of ice during January and February, 1897, twelve days; on account of high water during July and August, 1896, and February and March, 1897, fifty days. The highest stage of water during the year occurred February 28, 1897, when the lower canal gauge read 61 feet and the upper gauge 35.3 feet. The lowest reading on the same gauges was 5 feet and 3.3 feet, respectively.

In addition to the usual work of passing boats through the locks, the lock hands grouted the stone revetment on both sides of the locks between the lower and middle engine houses, to prevent weeds, grass, etc., growing between the stones and also to protect the gravel backing during high stages of water; assisted in the erection of the new gates; cleared the walls of mud deposit left by high water—in one instance this deposit ranged from 4 to 6 feet in depth—and made or aided in such ordinary repairs and police work as from time to time became necessary to maintain the locks and immediate vicinity in good condition. The towboat and dredges were employed in keeping the canal free from mud, drift, and other matter brought into it by high water; besides towing the mud scows to and from the dredges, the towboat handled the barges, derrick boats, etc., used in the construction work hereinafter described. She also towed the U. S. snag boat *Osseo* from the mouth of the Wabash River to the canal dry dock for repairs and conversion into a snag scow. Continual work with the dredges has been necessary whenever the stage of water would permit. The total quantity of dredging done during the year is exhibited by the following statement:

	Cubic yards.
Mud removed from canal and towed in scows to dumping place	90,313
Mud dredged and placed behind retaining wall, north side of canal	500
Sand and gravel for construction purposes dredged from river at Twelve-Mile Island and to canal in barges	535
Total	91,348

EXTRA LABOR.

Expenditures under this heading were for fencing placed on the property line from Thirty-first street to Thirty-third street and the river; breaking up and removing iron from off upper guard gates; new locks; removal of wrecked coal boat and coal from lower chamber of locks; grading embankments at bridge over old locks; care of hedges; planting trees on grounds, south side of locks, and at other points on the canal grounds.

GENERAL REPAIRS.

Work under this heading consisted in replacing the old check posts along the south canal bank with new ones; repairing washouts in the slopes caused by heavy rains; repointing masonry at Twenty-eighth Street Bridge; resurfacing roadway to dry dock with broken stone and screenings; repairs to wire fence at Eighteenth Street Bridge; repairing bridges over new and old locks; repainting water gauges; repairing and repainting towboat *Major Mackenzie;* replacing worn out frictions on engines at locks; making new wheel arms and fenders for towboat; replacing broken shaft on dredge; making new cams and lifters for towboat engine; rebuilding two piers under coal bin; repairing dredge dipper and placing new lip on same; repairing roofs of lock-engine houses damaged by high water and making and placing hold-down bolts to prevent further damage to same, and all minor repairs to the boats, buildings, and working plant that became necessary from time to time to maintain them in good condition.

MISCELLANEOUS, FUEL, OIL, ETC.

The expenditures under this heading were for coal, lubricants, cleaning material, fittings, and such other miscellaneous articles as were from time to time found necessary for minor repairs and maintenance of plant.

EXCAVATING CHANNEL BELOW LOCKS.

On account of the continued unfavorable stage of water throughout the year, and the fact that the plant on hand could not be spared from other work in progress, nothing was done under this heading, and for the latter reason nothing is contemplated during the next fiscal year. The item for this work has therefore been omitted from the estimate.

COMPLETING NEW LOWER GATES, NEW LOCK.

These gates were built of yellow-pine lumber by hired labor. The work of assembling the first leaf was commenced in September and completed in November, 1896; the second leaf was commenced in

November and completed in December, 1896. The north leaf of the old gates was thrown down at 11 a. m., May 21, 1897, and as the spaces between the bottom arms were filled with mud, immediately sunk to the bottom of the lock. This caused slight delay in erecting the new leaf, but it was raised into its place and made ready for operation at 7.30 p. m., on the date of removal of old leaf. On account of the high water and the apparent safety of the old south leaf, the erection of the new south leaf has been deferred until the next fiscal year. Its erection in place will be accomplished by the regular lock force and no additional expense incurred.

COMPLETING NEW UPPER GATES, NEW LOCKS.

One leaf of these gates was completed June 30, 1896; the other leaf was completed in August, 1896. They were built of yellow pine, after the same plan as those they were designed to replace. The south leaf of the old gates was thrown down, towed out of the way, and the new leaf erected in place August 13, 1896. The north leaf was erected in place August 20, 1896.

The old gates were placed in the dry dock, broken up, and the serviceable irons, nuts, bolts, etc., worked over and used in the construction of the new lower gates. The cost of the upper gates was as follows:

Labor	$2,111.97
Material	3,092.41
Total	5,204.38

RETAINING WALL, DRY DOCK.

On account of the available plant being in use elsewhere operations under this head were limited to a few minor repairs to the tracks and the purchase of the following quantities of stone, all of which has not been delivered:

	Cubic yards.
Special stone, at $9.50 per cubic yard	256.06
Coping stone, at $9.25 per cubic yard	174.32
Step stones, at $17.25 per cubic yard	6.88
Ashlar, at $7.75 per cubic yard	130.03

RETAINING WALL IN FRONT OF UNPROTECTED BANK.

Nothing was accomplished under this heading other than receiving and inspecting 1,168 cubic yards stone delivered by Mr. C. L. Cornwell under contract dated September 22, 1896.

RETAINING WALL TO REPLACE RUBBLE WALL.

At the beginning of the fiscal year there remained to be rebuilt 1,984 linear feet of this wall to carry it to the point of curve of the proposed wall at the westerly end of the enlargement opposite Fifteenth street. Work was carried on in the same manner as in previous years, viz, by tearing out the old dry rubble wall to the solid rock ledge and building new wall of ashlar stone laid in natural-cement mortar. As a matter of convenience and economy, not only for this work but for other work in the immediate vicinity, a spur track, connecting with and extending from the Kentucky and Indiana Bridge Company's railroad tracks down the slope of the south bank and wall to the basin below Eighteenth Street Bridge, was laid. The total length of track is 1,600 feet. The stone for rebuilding the rubble wall was delivered by the contractor on cars on this switch, whence it was taken by a derrick boat provided with derrick and turning winch and 12-foot turntable, placed on barges, taken to the site of work, and set in the wall direct from the barges. The work of setting stone in this wall was commenced October 26, 1896, and continued until January 18, 1897, when continued inclement weather caused work to be suspended for the winter. The work was interrupted by periods of high water and cold weather until June 1, after which work was continued till June 26, when the wall was completed to the point of its intersection with the proposed wall at the westerly end of the enlargement at the easterly end of the canal. Following is the quantity of work done during the year:

	Cubic yards.
Masonry constructed	2,569.1
Earth and rock excavated	1,440

AUTOMATIC GATE, OLD LOCKS.

Work on the foundation of this gate was commenced during the latter part of May, 1897. Before the rock excavation could be commenced it was necessary to tear down the old upper gates and remove 3,200 cubic yards mud from the chamber. The old gates were thrown down, broken up with dynamite, and removed to the chamber below the miter sill. The wickets in the guard gates were then opened and strong currents of water allowed to pass over the deposit of mud, by which means a large quantity of it was removed from the chamber; the remainder was removed by means of hose and a steam pump, the latter being supplied with steam from the boiler of the drill boat placed immediately above the guard gates. This boiler also supplied steam for a small steam drill used in the excavation of rock from the foundation for the new gate. All of the excavation for the foundation was completed June 30, 1897, and the holes for the hold-down bolts commenced. The hollow quoin castings and wicket frames have been completed and are ready to be put in place. The work of constructing and erecting the gate was advertised and proposals for doing the work under formal contract were received, but all of them were rejected on account of informalities. The work has again been advertised with a view of doing the work under proposals received after ten days' public notice.

DRY-DOCK GATES.

No expenditures under this heading were made during the year. At the time the estimate for 1897 was submitted it was proposed to build these gates of steel, at an estimated cost of $5,000, but upon removing the old lower gates, new locks, it was found that the lower 16 feet (the under-water portion) was sound and would probably last for twenty years. It was thereupon decided to convert these sound portions into gates for the dry dock at an estimated cost of $980.23 and thereby effect a saving of a little more than $4,000.

The special items referred to in this report, under the headings "Excavating channel below locks," "New lower gates, new locks," "New upper gates, new locks," "Retaining wall, dry dock," "Retaining wall in front of unprotected bank," "Retaining wall, to replace rubble wall," "Automatic gates, old locks," and "New gates, dry dock," are fully explained in Annual Report, Chief of Engineers, for the fiscal year 1896, on pages 2228 to 2234, inclusive.

WRECKS.

Only two wrecks occurred in the canal during the year. The first occurred about 4 a. m. on the morning of May 12, 1897, when the steamer *J. B. Williams*, Mr. Gus Jutte, master, sunk a coal boat loaded with 27,000 bushels of coal in 26 feet of water on the north side of the lower lock chamber. Mr. Jutte was at the steering wheel, and the accident was caused by his giving the wrong signal. Mr. Jutte at once abandoned the wreck and cargo and the United States derrick boat equipped with a Lancaster grapple was set to work removing it on the morning of the 13th. After about 21,000 bushels of coal had been removed with the grapple, and the water had fallen to a favorable stage, the dredge completed the work. No serious delay to navigation was experienced on account of the high stage of water prevailing at that time.

The second wreck occurred on May 20, 1897, while the steamer *Boaz* was passing down the canal with a tow of coal boats. She was caught in the current at the foot of Seventh street. One boat was carried through a break in the guiding dike and another sunk alongside the dike. In getting out of the current the steamer ran into and sunk a third boat about 50 feet from the north side of the canal. The wrecked boats and their contents were promptly removed by the owner, Mr. John W. Ailes, Pittsburg, Pa.

These wrecks caused but little obstruction to navigation, there being left a clear distance of 250 feet for the passage of boats.

The usual statements of expenditures, collections, etc., follow.

Expenditures for operating and care of Louisville and Portland Canal for the fiscal year ending June 30, 1897.

Operating and care of locks:	
Salaries of regular employees	$16,900.00
Extra labor	13.13
Repairs (labor)	992.37
Repairs (material)	917.67
Fuel	962.57
Oil	98.48
Miscellaneous	981.12
Total	20,865.34
Operating dredges and towboat:	
Salaries of regular employees	12,135.00
Extra labor	77.53
Repairs (labor)	3,315.86
Repairs (material)	1,380.17
Fuel	1,188.85
Oil	147.34
Miscellaneous	1,321.66
Total	19,566.41
Offices, general supervision, shops, etc.:	
Salaries of regular employees	14,665.00
Extra labor	3,585.66
Repairs (labor)	1,125.86
Repairs (material)	553.26
Fuel	331.52
Oil	105.72
Miscellaneous	1,880.99
Total	22,248.01

Completing new lower gates:

Labor	$2,022.42
Material	512.70
Total	2,535.12

Completing new upper gates:

Labor	720.81

Retaining wall, dry dock:

Labor	1.44
Material	5,200.00
Total	5,201.44

Retaining wall, to replace rubble wall:

Contract	4,518.54
Labor	5,360.83
Material	1,778.93
Total	11,658.30

Retaining wall, front of unprotected bank:

Contract	6,525.03
Labor	632.65
Material	1,434.18
Total	8,591.86

Automatic gates, old locks:

Labor	1,091.68
Material	547.83
Total	1,639.51

Total expenditures for the fiscal year ending June 30, 1897, including $12,225.81, outstanding liabilities on that date	93,026.80

During the fiscal year the following collections have been made and deposited to the credit of the Treasurer of the United States:

For rent of land pertaining to the Louisville and Portland Canal	$285.00
For rent of Louisville and Portland Canal dry dock by private boats	117.71
Total	402.71

Allotments for operating and care of Louisville and Portland Canal since July 1, 1880, when tolls were abolished and the canal became a direct charge on the Treasury of the United States.

May 18, 1880 *	$127,000.00	July 20, 1892	$102,175.94
March 3, 1881 *	88,000.00	July 13, 1893	77,158.68
July, 1884 *	73,000.00	September 9, 1893	2,000.00
August 3, 1885	91,840.00	July 11, 1894	114,528.08
July 28, 1886	82,320.00	November 27, 1894	1,500.00
July 2, 1887	77,805.00	July 12, 1895	112,838.28
July 13, 1888	99,456.79	July 28, 1896	123,715.05
July 20, 1889	55,548.88		
July 17, 1891	78,769.38	Total	1,307,656.08

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* From acts of these dates; date of allotments not available.

Abstract of proposals received in response to advertisement dated August 20, 1896, for furnishing and delivering stone, opened September 4, 1896, by Capt. W. T. Wood, Eighteenth Infantry, U. S. A.

[Total quantity of stone, approximately, 2,784 cubic yards.]

No.	Name and address of bidder.	Price per cubic yard f.o.b. cars Eighteenth street switch, Louisville, Ky.	Price per cubic yard f.o.b. barges in Louisville and Portland Canal.	Total amount of bid.	Kind of stone.	Remarks.
1	P. H. Sweeney, Jeffersonville, Ind.	....	$4.94	$13,752.96	Blue limestone....	
2	Edward Crumbo, New Albany, Ind.	$6.74	....	18,764.16	Oolitic limestone..	Sample No. 1.
3	.....do	9.24	....	25,724.16	.....do	Sample No. 2.
4	Salem-Bedford Stone Co., Louisville, Ky.	8.10	....	22,550.40	.....do	
5	Bedford Stone Mill Co., Bedford, Ind.	7.40	....	20,601.60	.....do	
6	Charles W. Moorman, Cloverport, Ky.	4.57	....	12,722.88	Sandstone	
7	Bedford Quarries Co., Bedford, Ind.	6.25	....	17,400.00	Oolitic limestone..	
8	The Rarden Stone Co., Rarden, Ohio.	7.50	....	20,880.00	Sandstone	Sample No. 1.
8	.....do	....	7.00	19,488.00	.....do	Do.
9	.....do	6.50	....	18,096.00	.....do	Sample No. 2.
9	.....do	....	6.00	16,704.00	.....do	Do.
10	Charles L. Cornwell, Louisville, Ky.	4.48	....	12,272.32	.....do	

Bid of C. L. Cornwell accepted for entire quantity.

Abstract of proposals for constructing and erecting automatic water gate in upper chamber of old locks of Louisville and Portland Canal, received in response to the advertisement dated May 13, 1897, and opened June 14, 1897, by Capt. W. T. Wood, Eighteenth Infantry, U. S. A.

No.	Name and address of bidder.	Total amount of bid.	Time required for completion.
1	Chas. Hegewald Co., New Albany, Ind	$3,858.00	65 working days.
2	Willard & Cornwell, Louisville, Ky	3,043.63	75 days.
3	Sulzer-Vogt Machine Co., Louisville, Ky	2,915.86	60 working days.
4	Snead Co. Iron Works, Louisville, Ky	10,284.00	125 days.
5	Geiger, Fiske & Co., Louisville, Ky	9,336.00	120 working days.

All bids rejected on account of informalities.

Abstract of contract.

Chas. L. Cornwell, for furnishing and delivering f. o. b. cars, on Louisville and Portland Canal switch, at Eighteenth Street Bridge, approximately, 2,784 cubic yards Cloverport sandstone, at $4.48 per cubic yard.

No contracts for this work were in force at the end of the fiscal year.

COMMERCIAL STATISTICS.

Vessels passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1897.

Kind of vessel.	Number.	Capacity.
		Tons.
Passenger boats	675	270,060
Towboats	732	104,187
Government boats	297	25,710
Coal boats and barges	2,658	754,368
Small craft	344	74
Total	4,706	1,154,399

Lockages, 3,148.

Commerce passed through the Louisville and Portland Canal during the fiscal year ending June 30, 1897.

Articles.	Tons.	Articles.	Tons.
Coal	813,660½	Hay	6,321
Corn	2,135	Straw	1,324
Wheat	6,395½	Cattle	5,997¾
Salt	4,521	Lumber	25,050
Oil	1,115½	Staves and shingles	19,955
Whisky	431½	Steel rails	38,152
Flour	1,036	Iron ore and manufactured iron	17,625
Sugar	1,123½	Produce	6,240¾
Molasses	3,763	General and miscellaneous	117,958
Cement	695½		
Tobacco	2,208½	Total	1,085,805½
Cotton	10,096½		

Number of passengers, 16,243.

Vessels passing Falls of the Ohio River, via Louisville and Portland Canal and Indiana Chute, June 30, 1881, to June 30, 1897.

Kind of vessel.	1881–1896.		1897.		Total for fifteen years.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.
Passenger boats	15,286	6,089,683	984	400,368	16,270	6,490,051
Government boats	2,520	196,617	313	27,290	2,833	223,907
Towboats	17,021	2,230,845	1,323	217,928	18,344	2,448,773
Coal boats and barges	61,438	19,732,183	4,023	1,136,961	65,461	20,869,144
Small craft	3,586	449	358	559	3,944	1,008
Rafts	70	2,577	....	....	70	2,577
Total	99,921	28,252,354	7,001	1,783,106	106,922	30,035,460

Annual average during past sixteen years—boats, 668+; tons, 1,877,216+.

Commerce passing Falls of Ohio River, via Louisville and Portland Canal and Indiana Chute, from June 30, 1886, to June 30, 1897.

Articles.	1886 to 1896.	1896 to 1897.	Total for eleven years.
	Tons.	*Tons.*	*Tons.*
Coal	14,851,953	1,544,805½	16,396,258½
Salt	98,665¾	5,300	103,965¾
Oil	54,462½	1,526½	55,989
Whisky	18,685¼	562½	19,247¾
Tobacco	75,541¾	8,441½	78,983¼
Cotton	102,998	12,893½	115,891½
Lumber	2,966,577¼	33,685	3,000,262¼
Corn and wheat	103,712¼	10,392½	114,104¾
Iron ore	293,689	17,625	311,314
Iron	132,005	....	132,005
Steel rails	395,340	64,055	459,395
Produce	66,830¾	7,157¾	73,988½
Hay and straw	158,364½	9,360	167,724½
Flour	12,832	1,613	14,445
Stock	73,817½	7,183¾	80,501¼
Sugar and molasses	80,694½	7,693½	88,388
Staves and shingles	361,391	24,438	385,829
Cement	33,144	861½	34,005½
Miscellaneous	826,791	153,610	980,401
Total	20,706,995	1,905,704½	22,612,699½

Annual average during past eleven years, 2,055,699 + tons.

E E 3.

IMPROVEMENT OF WABASH RIVER, INDIANA AND ILLINOIS.

For report of project see page 2239 Report of the Chief of Engineers for fiscal year ending June 30, 1896.

IMPROVEMENT BELOW VINCENNES.

Expenditures during the fiscal year ending June 30, 1897, were for the construction of guide dikes above the lock at Grand Rapids, the reconstruction of the old snag boat *Osseo* and its equipment as a snag scow, and a pro rata share of the expense of building, by contract, a small, light-draft towboat for use on this section of the river, that above Vincennes, and White River, Indiana.

The work of building the guiding dikes above the Grand Rapids Lock was commenced September 10, 1897, and, with the exception of a small quantity of stone filling and paving, was completed November 30, 1897.

The old snag boat *Osseo* being no longer serviceable as such, she was taken to Louisville, Ky., and after the unserviceable parts, such as steering gear, engines, wheel, etc., had been properly condemned the hull was placed in the dry dock, thoroughly repaired, and equipped as a snag scow, which it is expected will be much more efficient and able to work during a much lower stage of water than was possible with the larger self-propelling boat of greater draft. Besides this advantage, the scow can be operated at less expense, since it can be towed to the upper limits of the reach of river over which snagging operations are to extend and left to work downstream with a crew consisting of a foreman and sufficient number of laborers.

A new light-draft towboat 110 feet long, 24 feet wide, with maximum draft of 14 inches, was built by contract, and the expense paid as follows:

From appropriations for "Below Vincennes"	$1,250
From appropriations for "Above Vincennes"	3,5 0
From appropriations for White River, Indiana	2,000
Total	6,750

Previous to March 1, 1897, the expenses of operation and care of lock and dam at Grand Rapids were paid from appropriations for improvement; since that date these expenses have been paid from the indefinite appropriation for "Operating and care of canals and other works of navigation, allotment of March 12, 1897."

The details of work done during the year are set forth in the report of Mr. Thomas P. Shanks, assistant engineer, submitted herewith.

Money statement.

July 1, 1896, balance unexpended	$16,068.37
June 30, 1897, amount expended during fiscal year	8,899.46
July 1, 1897, balance unexpended	7,168.91
July 1, 1897, outstanding liabilities	150.75
July 1, 1897, balance available	7,018.16
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amounts and dates of appropriations.

June 10, 1872	$50,000	July 5, 1884	$30,000
March 3, 1873	50,000	August 5, 1886	60,000
June 23, 1874	25,000	August 11, 1888	60,000
March 3, 1875	40,000	September 19, 1890	60,000
August 14, 1876	70,000	July 13, 1892	60,000
June 18, 1878	50,000	August 17, 1894	15,000
March 3, 1879	20,000	June 3, 1896	15,000
June 14, 1880	25,000		
March 3, 1881	25,000	Total	695,000
August 2, 1882	40,000		

Abstract of proposals for furnishing and delivering a new towboat received in response to the advertisement dated September 25, 1896, and opened October 26, 1896, by Capt. J. G. Warren, Corps of Engineers.

No.	Name and address of bidder.	Price.
1	Ed. J. Howard, Jeffersonville, Ind	$6,750
2	Thomas M. Rees, Pittsburg, Pa	13,300

Bid of Ed. J. Howard accepted.

Abstract of contract.

That the said Ed. J. Howard shall furnish all the material and labor of every description, and construct and deliver one light-draft towboat in accordance with the specifications therefor; all for the sum of $6,750, to be paid said Howard when the boat shall have been delivered and accepted.

IMPROVEMENTS ABOVE VINCENNES.

No operations were in progress on this section of the river except the pro rata share of work in building the new towboat and the work of converting the good portions of the snag boat *Osseo* into a snag scow.

Money statement.

July 1, 1896, balance unexpended	$7,990.85
June 30, 1897, amount expended during fiscal year	5,778.24
July 1, 1897, balance unexpended	2,212.61
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	4,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amounts and dates of appropriations.

March 3, 1881	$25,000	July 13, 1892	$5,000
August 2, 1882	30,000	August 17, 1894	5,000
July 5, 1884	10,000	June 3, 1896	6,000
August 11, 1888	5,000		
September 19, 1890	5,500	Total	91,500

For commercial statistics see report for operating and care of lock and dam at Grand Rapids, Wabash River.

REPORT OF MR. THOMAS P. SHANKS, ASSISTANT ENGINEER.

OFFICE OF UNITED STATES ASSISTANT ENGINEER,
Mount Carmel, Ill., June 30, 1897.

CAPTAIN: I have the honor to submit the following papers as a report of operations on the Wabash River for the fiscal year ending June 30, 1897.

The only work of importance done during the year was the construction of two guiding dikes on the upstream approach to the lock at Grand Rapids. The shore dike, 150 feet long, 12 feet wide, and 15 feet high, has been built and filled with stone ballast all along the inside of the cribbing next to the exposed face; it is filled with earth in the back, and the whole of the upper 2 feet is filled with stone broken in small size on the top, as in macadamizing, and leveled even with the coping timbers. The proposed paving on top of the dike, to be laid after the filling had settled, has not yet been done. The river dike, 121 feet long, 15 feet wide at the lockhead wall and tapering to 8 feet at the point, and 15 feet high, has been built and partly filled with stone. No earth filling was placed in this dike, because both sides of it were exposed to the current. The quantity of stone required to complete the filling is 270 cubic yards. The work of building the dikes was commenced on the 10th of September, by constructing a temporary dam around the site of the dikes from the shore to the main dam, so as to drain the inclosure by opening the lock wickets; and the work proceeded without material interruption until the close of the season. The residence of the lock tender has been repainted inside and out; it has been repaired by laying new flooring in two of the rooms, putting new sash in five of the windows, and glazing parts of nearly all the others. The United States warehouse and blacksmith shop, which are built of rough boards, have received two coats of whitewash, and the carpenter shop has been painted. A picket fence has been constructed along the front of the buildings and neatly painted. The lawn has been graded and a few shade trees have been planted at what are thought to be appropriate points. The upper gates of the lock have been repaired; all the leakage from two bad joints has been stopped by inlaying a 2-inch oak board into the miter-sill and then carefully working it down to a water-tight joint. While there are yet some small leaks remaining, the large ones have almost entirely disappeared. All the lock gates have received two coats of paint.

The highest stage of water in seventeen years occurred on the 12th of March at an elevation of 26.75 feet above the low water at Grand Rapids Lock, lacking a height of only 1.85 feet of the disastrous flood of August, 1875.

The high water of July and August brought down a large quantity of drift, which lodged against the dam in all imaginable positions. The top branches of some of the trees were found to be matted with the roots of others and the whole tangled mass forced to the bottom by the crowding of the drift accumulating above them. In portions of the area the logs were 6 feet above the level of the water, making a depth of 16 feet of drift. The space covered was nearly 2 acres. It has all been removed at a cost of $211.74.

The cost of the work done at Grand Rapids, including the framing of 80,000 feet of old timber which was on hand and paid for out of previous appropriations, is as follows:

Moving the old timbers across the river	$99.42
Building the temporary dam	782.41
New lumber necessary to complete the dikes	977.47
Labor in constructing dikes	1,730.76
Removing temporary dam	65.27
Small items of expense consolidated	13.65
Construction of dikes	3,668.98
Repairs and painting lock gates, labor and materials	90.74
Repairs and painting buildings, materials therefor, fencing, grading lawn, etc	511.72
Removing drift from dam	211.74
Cleaning channel at entrance to lock	295.54
Removing property from U. S. steamer *Osseo*, loading her with property to be condemned, and taking her to the Ohio River	60.00
Total, not including salaries and office expenses	4,838.72

Respectfully submitted,

THOS. P. SHANKS, *Assistant Engineer.*

Capt. J. G. WARREN, *Corps of Engineers.*

E E 4.

OPERATING AND CARE OF LOCK AND DAM AT GRAND RAPIDS, WABASH RIVER.

The expenses for constructing, operating, and caring for this lock and dam were paid from appropriations for improving Wabash River, Indiana and Illinois, until March 1, 1897, since which date they have been paid from an allotment from the indefinite appropriation for operating and care of canals and other works of navigation. The expenses under this allotment have been for the salary of the lock tender (only one being necessary) and a few minor repairs and supplies.

The allotment of March 12, 1897, was as follows:

Salary of lock tender, four months, at $35	$140.00
Contingencies	100.00
Total	240.00

Following is a detailed statement of expenditures for operating and care of the lock and dam from March 1, 1897, to June 30, 1897:

Salary of lock tender, four months, at $35	$140.00
Supplies, oil, etc	8.00
Repairs	5.00
Total expenditures, including $40 outstanding liabilities June 30, 1897	153.25

Traffic and commerce through lock at Grand Rapids, Wabash River, for the year ending June 30, 1897.

TRAFFIC.

Kind of boat.	Number.			Tonnage.
	Up.	Down.	Total.	
Passenger	3	3	6	216
Tow	25	29	54	2,089
Government		2	2	220
Barges	40	40	80	2,801
House	4	15	19	72
Small craft	37	72	109	188
Rafts		27	27	2,284
Total	109	188	297	7,820
Passengers	325	325	650	
Lockages	69	94	163	

COMMERCE.

Articles.	Tons.
300 bushels wheat	9
37,700 bushels corn	1,320
Hay	10
1,217,958 feet B. M. lumber	2,284
125 head hogs	13
75 cubic yards stone	113
Total	3,749

E E 5.

IMPROVEMENT OF WHITE RIVER, INDIANA.

The only work accomplished during the year in connection with the improvement of this river was the proportional share in the construction and equipment of the small, light-draft towboat mentioned in the report for improvement of the Wabash River, below Vincennes, and the work of converting the old snag boat *Osseo* into a snag scow.

Full report of present project for improvement of this river will be found on page 2244, Report of the Chief of Engineers for the fiscal year ending June 30, 1896.

Money statement.

July 1, 1896, balance unexpended	$3,096.13
June 30, 1897, amount expended during fiscal year	2,284.39
July 1, 1897, balance unexpended	811.74

APPROPRIATIONS.

March 3, 1879	$25,000	August 11, 1888	$5,000
June 14, 1880	20,000	July 13, 1892	5,000
March 3, 1881	20,000	August 17, 1894	5,000
August 2, 1882	20,000	June 3, 1896	2,500
July 5, 1884	10,000		
August 5, 1886	7,500	Total	120,000

The total expenditures is $119,188.26, of which $2,284.39 was expended during the past fiscal year.

No satisfactory data concerning the commerce on this river could be obtained.

The detailed report of the resurvey of the river, made in compliance with the act of August 17, 1894, is contained in House Doc. No. 47, Fifty-fourth Congress, second session.

E E 6.

IMPROVEMENT OF TRADEWATER RIVER, KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, until May 14, 1897.]

No operations other than care of property and office work in connection with this river were in progress during the fiscal year ending June 30, 1897, and no statistics of commerce for the river can be obtained. Full report of project and list of all appropriations will be found on pages 2265 and 2266, Report of the Chief of Engineers for fiscal year ending June 30, 1896.

Work under the approved project is practically completed.

Money statement.

July 1, 1896, balance unexpended	$558.30
June 30, 1897, amount expended during fiscal year	126.78
July 1, 1897, balance unexpended	431.52

E E 7.

RECONSTRUCTION OF LOCK NO. 2, GREEN RIVER, AT RUMSEY, KENTUCKY—REBUILDING LOCK NO. 2.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, until May 14, 1897.]

During the fiscal year ending June 30, 1897, work under the approved project consisted in the construction of a guide crib extending downstream from the lower end of the land wall of the new lock, and filling, grading, and paving the irregular surface of the ground in the immediate vicinity. The details of the work are fully set forth in the report of Mr. G. F. Stickney, assistant engineer, hereto appended, and full report of the project for the work together with list of all appropriations therefor will be found on page 2266, Report of the Chief of Engineers for the fiscal year ending June 30, 1896.

The work remaining to be done comprises the construction of guide cribs above the new lock and completion of the grading and filling behind the land wall of the lock, for which purpose it is believed that the funds already available are sufficient and no further appropriation necessary.

Money statement.

July 1, 1896, balance unexpended	$16,686.40
June 30, 1897, amount expended during fiscal year	6,766.14
July 1, 1897, balance unexpended	9,920.26

APPROPRIATIONS.

March 3, 1893	$65,000
August 17, 1894	105,000
Total	170,000

REPORT OF MR. G. F. STICKNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1897.

CAPTAIN: I have the honor to submit the following report of operations for improving Green River, Kentucky, rebuilding Lock No. 2, for the fiscal year ending June 30, 1897:

The construction of the new lock was commenced in June, 1893, and the lock was completed and opened to navigation December 8, 1895. Work on the lock was suspended several times on account of lack of funds, the failure of contractors to deliver stone promptly, and high water. There remained considerable work to be done, such as building guide cribs, grading, paving, and cleaning up the premises. At the beginning of the present fiscal year there was available from the last appropriation the sum of $16,271.40 for the completion of the work. During the past year a guide crib has been built at the lower entrance to the lock, part of the space occupied by the old lock, between the new lock and the shore, has been filled and graded, and the space immediately back of the land lock wall has been paved. The following is a detailed statement of work done during the fiscal year ending June 30, 1897:

GUIDE CRIB.

A guide crib has been built, extending from the lower end of the land wall. This crib is 149 feet long, 25 feet high, 16 feet wide on the bottom, and 10 feet wide on top. The front face of the crib is built plumb and the rear face is plumb for 16 feet of its height, above which point the width is reduced by successive offsets. The crib was constructed of both hewed and sawed timber, which was on hand at the beginning of the year. A plank walk 2 feet wide was laid along the top for the entire length, and 6 timber heads for moorings were spaced at equal intervals along the center line of the crib. The following materials were used in its construction:

Hewed timber, 12 feet between faces, for range sticks	linear feet	8,424
Sawed timber, 6 by 12 inches by 16 feet, for cross-ties	feet B. M.	32,832
Sawed timber for walk, timberheads, etc	do	2,849
Riprap stone for filling	cubic yards	1,420
Spikes, ¾ inch by 18 inches	pounds	6,910
Miscellaneous bolts, spikes, etc	do	300

FILLING AND GRADING OVER OLD LOCK.

The work of filling and grading back of the new lock, over and around the old lock, has been continued at irregular intervals throughout the year, being done whenever the dredge boat could be spared from other work. The following amounts of stone, sand, mud, etc., have been dredged from the river and afterward, placed as follows:

	Cubic yards.
In the old lock chamber and over the walls	5,515
Below the old lock and up against its lower gates	1,080
Total	6,495

Of this amount 4,215 cubic yards was loaded into dump scows, which were dumped as close to the old lock as possible. Whenever a sufficient amount of material had accumulated, it was rehandled by the dredge boat and placed in the fill direct. Two thousand two hundred and eighty cubic yards of stone, sand, mud, etc., was loaded by the dredge boat onto the deck barges, from which it was loaded into wheelbarrows and placed in the fill. A total area of 2,000 square yards, about 70 per cent of the space to be graded, has been filled and brought to a plane one foot below the finished grade.

PAVING.

The space back of land lock wall has been paved with thin-bedded stone, set on edge. This space is 195.5 feet long, 31 feet wide in the center, and 24 feet wide at the ends, covering an area of 708 square yards. The following materials have been used in this paving:

	Cubic yards.
Sand	113
Stone	206

The following is a statement of cost of work for improving Green River, Kentucky, rebuilding Lock No. 2, during the fiscal year ending June 30, 1897:

Guide crib:		
Recutting timber	$150.00	
Materials	1,537.90	
Labor	1,321.52	
Incidentals	10.97	
		$3,020.39
Filling and grading over old lock:		
Dredging	1,145.67	
Labor	540.55	
		1,686.22
Paving:		
Materials	369.00	
Labor	255.17	
		624.17
Miscellaneous		16.30
Office expenses:		
Salaries	985.00	
Stationery	19.06	
		1,004.06
Total		6,351.14

All work was done by hired labor except recutting timber for guide crib, which was done under an informal contract, made after inviting proposals for ten days.

All materials were purchased under ten-day proposals except the stone for paving, which was purchased in open market, having been advertised for, but all bids received were excessive.

Very respectfully, your obedient servant,

G. F. STICKNEY, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers.

E E 8.

IMPROVEMENT OF GREEN RIVER, KENTUCKY, ABOVE MOUTH OF BIG BARREN RIVER (LOCK NO. 5).

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, until May 14, 1897.]

For report of project, see Report of Chief of Engineers for fiscal year ending June 30, 1896.

Operations during the present fiscal year were limited to the construction of a lock-tender's residence, temporary buildings for shops and storage purposes, and the transfer of machinery and tools used in the construction of Rough River Lock to the site of Lock No. 5, Green River, and setting them up ready for work at the latter place.

The work of excavating the foundation for the lock was commenced June 17, 1897. The details of the year's work are given in the report of Mr. William M. Hall, assistant engineer, submitted herewith.

It is deemed proper here to invite attention to the fact that the river within the limits of the proposed extension of slack-water navigation is badly obstructed by snags, rocks, overhanging trees, etc., and to remove which there are no available funds, the money now on hand being applicable only to the construction of the lock. The report upon which the project for improvement is based provides for the extension of slack-water navigation from the upper end of the pool above Lock No. 4, Green River, to Mammoth Cave, Ky., by the construction of two locks and dams at an estimated cost of $361,346.40. It is as essential, however, to have the pools free from obstructions as it is to have the locks and dams to overcome the fall and produce the requisite depth of water. It is therefore recommended that future appropriations for this work be made applicable to the whole reach of river under improvement, under the title of "Improving Green River, Kentucky, above mouth of Big Barren River, continuing improvement, etc."

Money statement.

July 1, 1896, balance unexpended	$88,459.05
June 30, 1897, amount expended during fiscal year	10,008.10
July 1, 1897, balance unexpended	78,450.95
July 1, 1897, outstanding liabilities	5,590.46
July 1, 1897, balance available	72,860.49
Amount (estimated) required for completion of existing project	85,673.20
Amount that can be profitably expended in fiscal year ending June 30, 1899	85,673.20

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry-civil act of June 4, 1897.

APPROPRIATIONS.

July 13, 1892	$50,000
August 17, 1894	25,000
June 3, 1896	20,000
Total	95,000

Abstracts of proposals for furnishing and delivering about 4,000 barrels Portland cement for building Lock No. 5, Green River, Kentucky, received in response to advertisement dated April 20, 1897, and opened May 6, 1897, by Maj. James F. Gregory, Corps of Engineers.

No.	Name and address of bidder.	Brand of cement.	Point of delivery.	Price per barrel.	Total.
1	Caleb E. Gowan, Cleveland, Ohio.	Lagerdorfer	Site of Lock No. 5	$2.69	$10,760
2	Manhattan Cement Co., New York, N. Y.	Germania	Bowling Green, Ky.	2.64	10,560
3	Commercial Wood and Cement Co., Philadelphia, Pa.	Saylor's American	Site of Lock No. 5	2.59	10,360

Bid of Commercial Wood and Cement Company accepted.

Abstract of contract, dated June 10, 1897, with Commercial Wood and Cement Company.

That the said Commercial Wood and Cement Company shall furnish and deliver, at the site of Lock No. 5, Green River, Kentucky, Saylor's American Portland cement in barrels containing not less than 380 pounds net weight of cement per barrel. All in accordance with the specifications therefor. That for said cement, delivered and accepted, the said Commercial Wood and Cement Company shall be paid at the rate of $2.59 per barrel.

The foregoing contract was not approved until July 6, 1897; hence there were no contracts in force at the close of the fiscal year.

NOTE.—For list of boats plying on Green River, and commercial statistics, see report for operating and care, etc., Green and Barren rivers, Kentucky.

REPORT OF MR. WILLIAM M. HALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1897.

CAPTAIN: I have the honor to submit the following report upon the improvement of Green River, Kentucky, above the mouth of Big Barren River (Lock No. 5), for the fiscal year ending June 30, 1897.

The money available for construction of Lock No. 5 at the beginning of the fiscal year was $88,459.05. But little was done toward construction during the season of 1896, for the reason that in its construction it is proposed, in the interests of economy, to use all the machinery, tools, etc., in the construction of Rough River Lock, and not required for further use there after the completion of that lock in December last.

Preparatory to the commencement of construction on the proposed lock general plans for a concrete lock, plan for artificial foundation for same, plan for concrete forms for lock walls, plan for cofferdam for inclosing lock, and plan for iron hollow quoins were prepared.

The adopted plans of lock have principal dimensions as follows:

	Feet.
Lock foundation over all:	
Width	74
Length	224
Length of lock masonry over all	220
Width of chamber	36
Height of walls above foundation	30
Width of head and tail walls on bottom	17
Width of head and tail walls on top	12
Width of chamber walls on bottom	14
Width of chamber walls on top, river wall	5
Width of chamber walls on top, land wall	5¼
Depth of water over lower miter sill	6
Lift of lock	14
Depth of water over upper miter sill	8
Height of upper guard wall	9
Miter of gates ......degrees	20

That part of plant used in the construction of the lock in Rough River, Kentucky, and which was released and not needed there after the completion of that lock, was moved and stored here in December last.

On April 1 the construction of a lock master's dwelling was commenced. The work of grading a yard for storage of materials, the erection of temporary buildings, erection of plant, etc., preparatory to construction of lock, was begun on May 18, 1897.

On June 17 a dredge was set to work excavating the lock foundation, and that date marks the time of commencing actual construction on the lock.

The work accomplished to date is as follows:

One lock master's dwelling, having stone foundation and consisting of seven rooms, a one-room cemented cellar, and an attic, has been completed. A cistern, double closet, and wood and coal shed have been completed. The grounds have been graded about dwelling and walks made, which required moving of 483 cubic yards of clay and building a stairway uphill to dwelling, making a rise of about 40 feet. The grading of yard about lock site for use in storing materials and erecting temporary buildings upon has been completed, which required the moving of 2,100 cubic yards of clay. Temporary buildings for use in construction have been erected as follows: One storeroom and cement shed, 22 by 100 feet; two engine sheds; one blacksmith and carpenter shop, 32 by 22 feet; one tool house and warehouse, 14 by 51 feet; one oil house, 14 by 12 feet; one building, 20 by 90 feet, for kitchen, and two dining rooms for use of mechanics and laborers. Plant has been erected as follows: Two hoist engines; two derricks; 1,310 feet of 30-inch gauge track laid; a wharf and wharf trestle, consisting of one stone-filled crib 30 feet long by 13 feet wide by 19 feet high, extending 7 feet below water; five bents of trestle from 7 to 20 feet high, and the excavation by dredge of 700 cubic yards of clay and 12 snags; one tank and about 1,600 feet of 1-inch and 1¼-inch service pipe laid.

Excavation for lock to date consists of 478 cubic yards moved by shovel and 2,150 cubic yards and 20 snags moved by dredge. All materials received, as enumerated above, have been unloaded, inspected, and stored.

The expenditures for the work named above is shown in the following table:

	Material.	Labor.	Total.
Lock master's dwelling	$958.19	$1,510.48	$2,468.67
Building cistern	51.88	46.45	98.33
Coal shed and closet, complete	91.25	130.00	221.25
Fencing grounds, 1,700 linear feet	108.80	109.80	218.60
Grading grounds, etc	33.45	174.40	207.85
Grading for yard for temporary buildings, storing material, etc		586.50	586.50
Erection of temporary buildings	711.31	482.00	1,193.31
Laying track and erecting plant	82.38	280.40	362.78
Erection of wharf and wharf trestles		250.25	250.25
Dredging for wharf		87.96	87.96
Excavation for lock, dredge		305.60	305.60
Excavation for lock, picks and shovels	11.75	125.00	136.75
Unloading, storing, and inspecting material		1,132.09	1,132.09
Preparing plans, bills of material, and advertisements		700.00	700 00
Grading road to highway		71.65	71.65
Repairing tools and plant		91.60	91.60
Drainage of grounds	609.80	87.75	697.55
Watching plant		309.73	309.73
Quarrying stone for concrete	120.35	381.22	501.57
Removing plant from Rough River Lock to site of Lock No. 5	559.80		559.80

Other expenditures to date for materials received are as follows:

Material for use in construction of lock and dam	$764.42
Material for use in concrete-lock construction	194.64
Timber and iron for use in construction of cofferdam	1,844.24
Timber for use in construction of foundation	259.04
Timber for use in construction of temporary trestles	297.46
Vitrified pipe for drainage culvert in lock wall	288.00

The remaining work proposed for the season is as follows:

The excavation of about 20,000 cubic yards of material necessary for putting in lock foundation; the building of cofferdam 266 feet long by about 80 feet wide; the construction of the entire pile and timber foundation for lock 74 feet wide by 224 feet long; the construction of land wall of lock, requiring the placing of about 2,903 cubic yards of concrete, and the filling back of land wall.

It is not expected that the river wall for lock will be constructed this season, for the reason that the available funds are not considered sufficient to do that in addition to the work mentioned above.

Preparations would have been made for constructing the abutment in addition to the work now proposed but for the fact that the title for land on abutment shore of river has not been perfected.

No accident to property or any employee of a serious nature has occurred since the commencement of the work.

Very respectfully, your obedient servant,

Wm. M. Hall, *Assistant Engineer.*

Capt. J. G. Warren,
Corps of Engineers.

E E 9.

OPERATING AND CARE OF LOCKS AND DAMS ON GREEN AND BARREN RIVERS, KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, until May 14, 1897.]

For report of general project see page 2272, Report of Chief of Engineers, for fiscal year ending June 30, 1896.

Special work during the past fiscal year consisted of extensive repairs made to the dam and abutment at Lock No. 1, Green River; the construction of a warehouse, and grading the ground back of land wall at Lock No. 4; completing and setting up in place new upper gates and cast-iron hollow quoins at Lock No. 1, Barren River; the construction of a new hull for the dredge; extensive repairs to the United States snag boat *Wm. Preston Dixon;* the construction of two deck barges and two derrick boats; and the usual work of passing boats, etc., through the locks. Snagging and dredging were performed as usual and work of making minor miscellaneous repairs to the several locks and dams, lock-tenders' houses, boats, and working plant, was done from time to time, as became necessary to maintain the whole system in good navigable condition.

Two items in last year's estimate provide for work which has not yet been practicable to commence, viz: the work of rebuilding Dam No. 2 and the construction of a concrete reinforcement to the lower end of river wall of Lock No. 4. However, the greater part of the material for these purposes has been purchased and delivered at the respective places where it is to be used, and it is expected to carry the work to completion previous to the winter of 1898.

The full details of the year's operations are set forth in the report of Mr. G. F. Stickney, assistant engineer, submitted herewith.

Leases of land, and water power, in force during fiscal year ending June 30, 1897.

Location.	Lessees.	Date.	To expire.
Lock No, 2, Green River	Livers & Welborn	Jan. 1, 1892	Jan. 1, 1912
Lock No. 1, Barren River	William Boulton	July 1, 1878	July 1, 1898

Collections for use of land and water power, Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1897.

Lessees.	Location.	Subject.	Amount collected.
Livers & Welborn	Lock No. 2, Green River	Land and water power	$100.00
William Boulton	Lock No. 1, Barren River	do	225.00
Bryant & Nall [a]	Lock No. 2, Green River	do	150.00
C. H. Hemenway [a]	Lock No. 3, Green River	do	37.50

[a] Verbal leases made from year to year.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, improved by locks and dams, during the fiscal year ending June 30, 1897.

Month.	Lock No. 1, Green River.				Lock No. 2, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.								
July	$169.50	$35.60	....	$205.10	$180.00	$9.10	....	$189.10
August	180.00	84.75	$18.50	283.25	180.00	17.32	$19.21	216.53
September	205.00	788.68	11.85	1,005.53	205.00	39.35	4.00	248.35
October	342.00	2,622.06	1.15	2,965.21	192.00	25.30	5.25	222.55
November	322.85	2,687.93	14.24	3,025.02	172.83	73.82	27.81	274.46
December	344.00	1,637.17	18.09	1,999.26	194.00	218.02	11.49	423.51
1897.								
January	310.35	1,105.68	7.50	1,423.53	160.33	42.17	7.50	210.00
February	338.00	935.12	14.40	1,287.52	188.00	10.96	11.40	210.36
March	267.00	393.39	4.00	664.39	267.00	14.71	4.00	285.71
April	224.00	....	11.50	235.50	224.00	6.48	32.60	263.08
May	152.00	....	4.23	156.23	152.00	2.40	3·73	158.13
June	165.00	....	8.00	173.00	280.00	10,469.74	6.00	10,755.74
Total	3,019.70	10,290.38	113.46	13,423.54	2,395.16	10,929.37	132.99	13,457.52

Month.	Lock No. 3, Green River.				Lock No. 4, Green River.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.								
July	$180.00	$10.90	....	$190.90	$180.00	$1,458.25	....	$1,638.25
August	180.00	87.40	$26.27	243.67	180.00	760.75	$38.58	979.28
September	205.00	105.21	4.00	314.21	205.00	762.63	4.20	971.83
October	192.00	34.10	....	226.10	192.00	11.40	....	203.40
November	172.83	19.66	20,73	213.22	172.83	75.56	20.73	269.12
December	194.00	21.44	11.49	226.93	194.00	91.72	11.49	297.21
1897.								
January	160.33	13.49	15.00	188.82	160.33	486.00	15.00	661.33
February	188.00	3,026.97	11.40	3,226.37	188.00	625.69	16.09	829.78
March	267.00	22.00	4.00	293.00	267.00	529.10	8.50	804.60
April	224.00	22.05	19.00	265.05	224.00	592.72	19.00	835,72
May	152.00	19.35	3.72	175.07	152.00	26.90	4.22	183.12
June	180.00	22.75	10.25	213.00	480.00	4,200.00	10.50	4,690.50
Total	2,295.16	3,355.32	125.86	5,776.34	2,595.16	9,620.72	148.26	12,364.14

Month.	Lock No. 1, Barren River.				U. S. snag boat Wm. Preston Dixon.				
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries and labor.	Repairs.	Subsistence.	Supplies.	Total.
1896.									
July	$180.00	$1,671.64	....	$1,851.64	$858.00	....	....	....	$858.00
August	180.00	829.28	$49.22	1,058.50	855.17	$45.00	$400.47	$260.49	1,561.13
September	205.00	15.10	4.00	224.10	859.67	....	97.36	88.02	1,045.05
October	102.00	9.10	....	201.10	828.83	....	....	10.82	839.65
November	172.83	15.46	20.73	209.02	828.33	....	149.16	115.62	1,093.11
December	194.00	1.60	11.49	207.09	816.67	97.73	247.98	353.56	1,515.94
1897.									
January	160.33	5.01	15.00	180.34	717.14	2.40	293.84	238.48	1,251.86
February	188.00	804.85	11.39	1,004.24	461.33	4.90	17.63	42.00	525.86
March	267.00	603.00	4.00	874.00	508.00	....	31.40	82.11	621.51
April	224.00	....	19.00	243.00	476.99	885.90	220.38	144.01	1,727.28
May	152.00	....	3.72	155.72	1,179.30	....	33.96	30.47	1,243.73
June	180.00	....	20.00	200.00	1,220.00	5,174.69	220.00	40.00	6,654.69
Total	2,295.16	3,955.04	158.55	6,408.75	9,609.43	6,210.62	1,711.68	1,405.58	18,947.31

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Green and Barren rivers, Kentucky, etc.—Continued.

Month.	U. S. dredge boat Lermond.			
	Salaries and labor.	Repairs.	Supplies.	Total.
1896.				
July				
August	$366.00		$52.22	$418.22
September		$2.39	20.58	22.97
October	69.17			69.17
November	415.00	42.98		457.98
December	415.00	612.00	10.99	1,037.99
1897.				
January	83.00		.25	83.25
February	70.33	1.00	19.00	90.33
March	219.17	20.00	28.55	267.72
April	135.00			135.00
May	171.89	2,090.55	.50	2,262.94
June	490.00	30.75	70.80	591.55
Total	2,434.56	2,799.67	202.89	5,437.12

Two new barges	$3,823.02
Two derrick boats	3,928.70

RECAPITULATION.

Lock No. 1, Green River	$13,423.54
Lock No. 2, Green River	13,457.52
Lock No. 3, Green River	5,776.34
Lock No. 4, Green River	12,364.14
Lock No. 1, Barren River	6,408.75
U. S. snag boat *Wm. Preston Dixon*	18,947.31
U. S. dredge boat *Lermond*	5,437.12
Two new barges	3,823.02
Two new derrick boats	3,928.70
Total expenditures for fiscal year ending June 30, 1897, including $20,476.26 outstanding liabilities	83,566.44

AMOUNTS AND DATES OF APPROPRIATIONS AND ALLOTMENTS.

Appropriations.

August 11, 1888	$135,000.00

Allotments.

January 4, 1889	$167,112.00
July 20, 1889	139,110.00
July 17, 1890	53,783.47
July 16, 1891	77,807.26
July 15, 1892	46,264.26
July 15, 1893	49,730.88
July 13, 1894	25,927.23
January 26, 1895	6,000.00
July 20, 1895	51,080.31
Total	616,815.41

Report of lockages on Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1897.

Lock.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number of lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1, Green	274	91	464	274	83	455	265	226	74	1,841	2,365
No. 2, Green	299	66	468	321	119	467	311	239	133	2,058	2,352
No. 3, Green	307	58	437	256	69	430	266	103	75	1,638	1,705
No. 4, Green	316	49	620	412	25	629	408	53	28	2,175	2,154
No. 1, Barren	348	17	422	230	42	420	221	10	62	1,407	1,288
Total	1,544	281	2,411	1,493	338	2,401	1,471	631	372	9,117	9,864

NOTE.—Locking through No. 1, Green River, was suspended 91 days on account of high water; through No. 2, Green River, 66 days on account of high water; through No. 3, Green River, 58 days on account of high water; through No. 4, Green River, 15 days on account of repairs to lock gates, 2 days on account of ice, and 32 days on account of high water; through No. 1, Barren River, 17 days on account of repairs to lock gates.

List of boats plying on Green and Barren rivers, Kentucky, during the fiscal year ending June 30, 1897.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Wm. Preston Dixon	U. S snag boat	124.9	32	5	200
Col. G. L. Gillespie	U. S. towboat	110	25	3	82.50
Gayoso	Passenger	127.8	30	6	197.99
City of Clarksville	do	125	24	3.8	194.60
Evansville	do	121	30.2	5	194.24
J. C. Kerr	do	120	25	4	125.97
Janie Rae	do	110	25.9	3	99.54
Mary Stuart	do	100	20.6	3.6	90.20
Lela	do	70	18	3	63.27
Peankishaw	do	80.9	20.2	3.6	58.18
Fawn	do	96	25	3.5	46
E. L. Reel	do	76	14	3	34.52
Gihon	do	70	17	3.8	29.18
Jack Osborne	Towboat	136.6	30	4.6	188.51
Longfellow	do	112	19.6	4.3	93.59
Emma Cooper	do	95	25	3.5	79.10
Penguin	do	80	16.6	3.4	60.68
Little Tom Moss	do	90	22	3	56.30
I. N. Hook	do	109	19.4	3	55.95
Racket	do	99	16.2	3.6	52.84
Little Clyde	do	100	20	3.6	52.20
John T. Carson	do	85	18.8	3	47.60
J. B. Horton	do	65	14	4	36
Royal Pierce	do	70	17	3.3	29.18
Ida	do	60	14	3	22
C. O	do	81.6	15.7	2.7	19.84
Eleanor	do	60	16	2.8	14.64
Isabella	Tugboat	95	22	4.8	66.24
Herbert Moran	do	94	16	6	51.98
Blanche	do	92	17	3.8	48.40
Hussar	do	80	15	4	39
Ingleside	do	81	14	4	36
Edmund	do	56	12	3	14.54
Louisa	do	73	16.5	3.8	40.80
Lena Archer	do	45	9	4	8
Frank Von Behren	Sawmill boat	116	24	3	94
Rover	do	100	18	3.6	65
Three Brothers	do	100	20	2.8	52.80
Mary Agnes	Pleasure boat	30	7.5	2.5	5.62
Sadie	do	31.5	6	4	3
Josephine	do	25	4	2	1
City of Hartford	Gasoline boat	....	....	....	....

Commercial statistics of Green and Barren rivers, Kentucky, for fiscal year ending June 30, 1897.

	Tons.		Tons.
Timber, logs, etc	148,760	Lumber	6,889
Beer	238	Merchandise	14,699
Cement	387	Produce	39
Coal	20,110	Salt	922
Flour	1,220	Stone	2,853
Grain	1,956	Staves and headings	3,206
Handles	2,967	Ties, railroad	92,504
Hay	385	Tobacco, leaf	1,880
Hides	30	Whisky	38
Hooppoles	553		
Iron, manufactured	57	Total	303,475
Live stock	3,782		

Passengers .... number.. 1,740

REPORT OF MR. G. F. STICKNEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1897.

CAPTAIN: I have the honor to submit the following report of operations pertaining to operating and care of, etc., Green and Barren rivers, during the fiscal year ending June 30, 1897. The allotment for operating and care of Green and Barren rivers during the year was as follows:

Lock No. 1, Green River:	
Repairs to dam	$5,150.00
Repairs to abutment	256.00
Salaries of lock hands and office expenses	2,900.00
Contingencies	1,000.00
	9,306.00
Lock No. 2, Green River:	
Repairs to dam	19,365.00
Salary of lock hands and office expenses	2,900.00
Contingencies	500.00
	22,765.00
Lock No. 3, Green River:	
Salary of lock hands and office expenses	2,900.00
Contingencies	500.00
	3,400.00
Lock No. 4, Green River:	
Repairs to river lock wall	10,616.43
Filling and grading behind land wall	2,154.00
Storehouse	1,200.00
Completing new upper lock gates	748.80
Salary of lock hands and office expenses	2,900.00
Contingencies	750.00
	18,369.23
Lock No. 1, Barren River:	
Completing new upper lock gates	664.80
Salary of lock hands and office expenses	2,900.00
Contingencies	500.00
	4,064.80

U. S. snag boat *Wm. Preston Dixon:*	
Repairs to snag boat	$5,883.35
Operating snag boat	12,500.00
	18,383.35
U. S. dredge boat *B. O. Lermond:*	
New hull	1,780.00
New clam-shell bucket	750.00
Operating dredge boat	4,500.00
	7,030.00
Two new deck barges	3,400.00
Two new derrick boats	3,400.00
	6,800.00
Total estimate for fiscal year ending June 30, 1897	90,118.38

The following is a detailed statement of the work done during the year:

LOCK NO. 1, GREEN RIVER.

Repairs to dam.—Two sections of the upper portion of the dam above the crest, aggregating 309 linear feet, have been rebuilt, as follows: 240 linear feet at the east end of the dam and 69 linear feet at the west end. The middle section, 205 linear feet, was repaired in 1894. A section of the lower slope of the dam, 100 feet long, has been repaired by renewing the three upper courses of range sticks and replacing the sheathing which had been carried off during the high water of the past season. The upper slope of the dam is 24 feet long and lower slope 30 feet long. The materials for repairing the dam, with the exception of the sheathing and sheathing spikes for lower slope, had been received during the previous year. The rebuilding of the upper slope was done in three sections, which were successively inclosed with cofferdams of riprap stone backed with hickory lathe turnings. The frame of the dam was constructed of hewed timber, the sheathing and comb stick of sawed timber. The following materials have been used in this work:

Hewed gum timber, 12 inches between faces, for frame of dam	linear feet	9,146
Sawed gum timber, for sheathing	feet B. M.	50,392
Riprap stone, for filling	cubic yards	1,963
Driftbolts, spikes, etc	pounds	7,627

Repairs to abutments.—The abutments of the dam were built, originally, as the foundations for mills, operated by water power, and at the west abutment the water was drawn through three gates in the stone foundation, considerably below the level of the crest of dam. At the bottom of these openings 12 by 12 inch timbers were laid through the width of the wall and extending across the three openings. These timbers had decayed, causing leaks through the abutment and weakening the wall. The portion of wall above the openings was torn down, the timbers removed, and the wall rebuilt; the work being done while this end of the dam was inclosed with a cofferdam. Eighty-seven yards of stone wall was torn down. It was found that the wall had been dry laid, with cement only in the joints on the face. The section of wall rebuilt contains 90 cubic yards of stone, which was laid in cement mortar. On the east abutment, reset 4 coping stones and repointed 49 linear feet of joint. There have been used in this work:

Natural cement	barrels	40
Sand	cubic yards	18

General work.—Painted both sets of lock gates, and whitewashed outbuildings and fences; built 2 concrete monuments at corners of Government land on east side of river. These monuments were made by sinking cement barrels in the ground, for one-half of their height, with an iron rod set upright in the center of each barrel, projecting slightly above the top, to mark the exact corner. The barrels were then filled with concrete, which was allowed several days to harden, after which the staves were cut off, the monuments smoothed up with cement mortar and whitewashed.

Highest water occurred March 3, 1897, upper gauge reading 33.3 feet. Lowest water occurred, above the dam, August 22, 1896, upper gauge reading 5.2 feet; and below the dam, September 21-22, 1896, lower gauge reading 4.8 feet. The walls of the lock have been submerged seventy-two days during the year.

LOCK NO. 2, GREEN RIVER.

Repairs to dam.—The repairs to the dam have not been started yet, as the stage of water has not been favorable, and nothing has been done beyond receiving and storing materials. It is expected that the work will be completed during the next fiscal year. The following materials have been received and stored:

Gum timber	feet B. M.	134, 828
White-oak timber	do	78, 576
Iron, spikes, etc	pounds	47, 582

Sixty-five thousand three hundred and thirty-three feet B. M. yellow-pine lumber has been received and loaded on a barge, to be taken to Lock No. 2, Green River.

General work.—Painted both sets of lock gates, and whitewashed outbuildings and fences; built a fence around the Government land. From the water edge up to the top of the bank the fence was made of old 6 by 12 inch timbers set on end and spaced about 6 inches apart; the timber was cut into 8-foot lengths, of which 3 feet was set in the ground, leaving 5 feet projecting above the ground. The fence on top of the bank was constructed of 10-bar woven wire, 46 inches high, with one strand of barbed wire along the top. The fence posts are of cedar, 8 feet long, set 3 feet in the ground, and spaced 20 feet apart. The length of fence constructed is as follows:

	Linear feet.
Woven-wire fence, with cedar posts	1, 330
Timber palings	188

The lock hand's house has been put in thorough repair, as follows: Put new windows, doors, and a concrete floor in the basement; laid a drain of vitrified pipe from basement to mill race, 140 linear feet; rebuilt the chimney tops, replastered the kitchen, built a porch on one side, wainscoted two rooms, painted all woodwork, and papered two rooms; tore down old smokehouse and stable and constructed a coal shed from the materials. The lock master's house has been repaired by putting a corrugated iron roof over the kitchen, renewing one window sash, and papering two rooms.

Filled 22 cubic yards of stone into one of the buttress cribs of dam, to replace that washed out during high water. Placed 63 cubic yards of earth and stone below lower guide crib to stop the current flowing across entrance to lock.

Highest water occurred March 19-20, 1897, upper gauge reading 30 feet. Lowest water occurred September 16, 1896, upper gauge reading 6.8 feet. The walls of the lock have been submerged fifty-nine days during the year.

LOCK NO. 3, GREEN RIVER.

General work.—Painted both sets of lock gates and whitewashed outbuildings, fences, etc. Repaired lock gates by removing 20 broken fenders and replacing same with new fenders. Rebuilt steps and platform on front of tool house and constructed platform for oil tanks.

Highest water occurred February 28 to March 1, 1897, upper gauge reading 24.3 feet. Lowest water occurred October 29 to November 5, 1896, upper gauge reading 4.9 feet. The walls of the lock have been submerged forty-nine days during the year.

LOCK NO. 4, GREEN RIVER.

Repairs to river lock wall.—The repairs to river wall have not been started yet, but the following materials have been received and stored:

Red-oak timber for cofferdam	feet B. M.	38, 187
Yellow-pine timber for concrete forms	do	29, 430
Iron for cofferdam	pounds	11, 961
Iron for concrete forms	do	7, 243
Saylor's Portland cement for concrete	barrels	1, 120
Broken stone for concrete	cubic yards	493

It is expected that the work will be done during the first months of the next fiscal year

Filling and grading behind land lock wall.—Back of the land lock wall was a channel that formerly admitted water to the water wheel of a mill. The lower end of the channel was closed by a crib built of timber and stone. The timber of the crib was badly decayed, and the crib was liable to give way if subjected to any pressure.

The place was unsightly; access to the lock wall was difficult on account of the mill race, and there did not seem to be much probability that the water power would ever be leased again. The mill race has been almost entirely filled up, the space graded, and a strip of paving laid along back of the lock wall. Five thousand four hundred and fourteen cubic yards of earth, stone, and gravel have been placed in the old mill race. Of this amount 1,515 cubic yards were taken so as to grade a site for a storehouse, and from the bed of the wagon road through the lock grounds, reducing the grade and improving the road considerably. The remaining 3,899 cubic yards was dredged from a gravel bar in the river below the lock. Two hundred and forty-four square yards of paving back of lock wall has been laid, consisting of thin bedded stone set on edge.

Storehouse.—There has been great need for a storehouse, conveniently located, and of sufficient size to contain all tools and appliances used on the rivers when not in service. The new storehouse is situated just above the level of extreme high water, back of the lock wall. The lock is reached by an incline about 120 feet long. The storehouse is a frame structure resting on a stone foundation, 75 feet long, 30 feet wide, with walls 10 feet high. The frame and floor are of oak, the siding and the sheathing of the roof is yellow poplar. The roof is covered with corrugated iron.

Completing new upper lock gates.—At the beginning of the fiscal year all the materials for new upper lock gates had been received, and the construction of the gates had commenced. The old lock gates were removed, a cofferdam built across the upper end of the fore bay, and the new gates were set up in place. The old stone hollow quoins, being worn and broken so that they leaked badly, were cut out and new cast-iron hollow quoins were substituted, being bedded in cement mortar and bolted to the masonry. New anchor irons, let into the top of the wall, were employed in place of the old type of anchorage, which projected above the top of the wall. The land wall, being too thin to provide sufficient anchorage, was reenforced at the back with 9 cubic yards of concrete. The coping stones around the heel of each gate, having been badly broken, were taken up and replaced, about 28 square yards of new 15-inch coping being set. The timber for the gates was dressed, the gates put together upon the bank, and the irons fitted. After the new hollow quoins had been put in place, the gates were taken apart, and rebuilt in place. The fore bay was sheathed with 2-inch oak timber to stop leaks through the breast wall. Navigation was suspended for fifteen days while the gates were being set up.

General work.—Painted both sets of lock gates, and whitewashed outbuildings, fences, etc. The uninclosed portion of the Government land has been fenced with a ten-bar woven wire fence 46 inches high, with one strand of barbed wire along the top, stretched between cedar posts spaced 20 feet apart and set 3 feet in the ground. The amount of fence built is 1,180 linear feet.

Rebuilt chimney and made minor repairs to lock master's house. Moved two small storehouses to new sites in order to provide room for large storehouse. Two concrete monuments have been built on the southeast boundary line of the lock grounds, similar to those constructed at Lock No. 1, Green River.

Highest water occurred February 20, 1897, upper gauge reading 27.5 feet. Lowest water occurred September 15–17, 1896, upper gauge reading 6.4 feet. The lock walls have been submerged thirty-one days during the year.

LOCK NO. 1, BARREN RIVER.

Completing new upper lock gates.—At the beginning of the fiscal year the materials for new upper lock gates were on hand and the gates were under construction. New cast-iron hollow quoins and new anchor irons were provided, and the gates were constructed and set up in similar manner to those at Lock No. 4, Green River. It was found that the land wall overhung about 1¼ inches. The face of this wall was dressed off at the gate recess in order that the gate might open back into the recess. The floor of the forebay was sheathed with 2-inch oak timber, to stop leaks through the breast wall. Navigation was suspended for seventeen days, while the gates were being set up.

General work.—Placed 500 cubic yards of hickory lathe turnings on upper slope of dam to stop leaks in same. Painted both sets of lock gates, whitewashed outbuildings, fences, etc., papered six rooms, and made minor repairs to lock houses.

Highest water occurred February 24–25, 1897, upper gauge reading 16.4 feet. Lowest water occurred September 12–14, 1896, upper gauge reading 6.2 feet. The lock walls have not been submerged during the year.

U. S. SNAG BOAT WM. PRESTON DIXON.

Repairs to snag boat.—The hull of the snag boat is a composite construction of iron and wood, the gunwhales, keelson, and bulkheads being iron, while all the remainder of the hull is of wood. All the timber in the hull, except the main bottom and the stern rake, was decayed. Various parts of the machinery had been worn out in service and needed renewing. The repairs to the snag boat have been made at the Louisville and Portland Canal Dry Dock, and are almost completed, the following work having been done:

All floor beams, all deck beams, the head stick, main deck, and stationary fenders have been renewed with yellow-pine timber. Several new planks in the bottom, and a new forward rake of white oak have been put on. The gunwhales and keelson, from amidship aft, have been raised, taking out the reverse shear in after part of the deck. The deck, bottom, and rakes have been calked. The boat has been furnished with new smokestacks, new breeching, new steam drum, new ash pan, and new cast-iron back plate to boilers. The main engines have been furnished with new, brass-filled packing rings on pistons; the capstan engines with new slide brasses, and new packing rings on pistons. New flanges have been put on mud drums. The cylinder timbers have been repaired and stiffened by riveting reenforcing plates on the bottom flanges. The shifting rigging on main engines has been changed to below deck; the forward part of the boiler deck and the hurricane deck have been lengthened 5 feet, giving considerable more deck room. The two flights of stairs, leading to boiler deck, have been removed, and one flight substituted, considerably increasing the size of the coal box, which is underneath. The size of the forward cabin has been increased by moving one bulkhead and moving the smokestacks outboard. Alterations have been made to doors and windows. The front of the pilot house has been closed with sliding sashes; the bulkheads have been repaired, and also the guards, railings, etc., above the main deck. Steam heaters have been provided for the entire cabin, texas, and pilot house. A new canvas roof has been put on the entire boat, and the boat has been partially painted. There still remains some work to be done about the machinery, such as riveting steam drum on boilers, setting up breeching and smokestacks, altering escape pipes, etc. It is expected that the repairs will be completed in a few days.

Operating snag boat.—The snag boat has been in commission two hundred and eighty-one days during the year, part of which time was spent at the Louisville and Portland Canal Dry Dock (during April, May, and June) in making repairs. In addition to removing snags from the channel of the rivers and cutting or deadening overhanging trees, the boat has been engaged in doing the necessary towing of dredge, scows, barges, and derrick boats between the various locks; assisting in building cofferdams at Lock No. 1, Barren River, and Lock No. 4, Green River, and taking rock soundings on Green River, below Lock No. 1; running to Frankfort, on the Kentucky River, towing Kentucky River barge to Carrollton and Kentucky River Dredge No. 1 to Louisville and Portland Canal Dry Dock.

During the year the snag boat ran 6,002 miles, cut and deadened 74 overhanging trees, and removed 968 snags, located as follows:

	Snags.
Below Lock No. 1, Green River	30
Between Locks No. 1 and No. 2, Green River	325
Between Locks No. 2 and No. 3, Green River	344
Between Locks No. 3 and No. 4, Green River	174
Barren River from mouth to Bowling Green	95
Total	968

U. S. TOWBOAT COL. G. L. GILLESPIE.

The towboat has been engaged during the past twenty days in towing barges, derrick boats, etc., on Green and Barren rivers, and during this period has run 802 miles.

U. S. DREDGE BOAT B. O. LERMOND.

New hull.—Most of the materials for constructing a new hull for the dredge boat were on hand at the beginning of the fiscal year, having been provided for in the estimate for the previous year. The hull has been built complete, the cabin and machinery transferred from old hull, and new "A" frame, spuds, and dipper arms provided. The hull is 112 feet long, 31 feet wide, 4 feet deep, and is constructed of long-leaf yellow pine, excepting the streamers, rake frames, spuds, and kevels, which are made of white oak. The dredge boat was painted and a new canvas roof put on the cabin.

New clam-shell bucket.—A new Lancaster (1½ cubic yards) clam-shell bucket has been purchased to replace one worn out in service.

Operating dredge boat.—The dredge boat has been employed at each of the locks in freeing the entrances and lock chambers from mud, sand, leaves, etc.; at Lock No. 1, Green River, dredged stone, etc., from cofferdams above the dam; at Lock No. 4, Green River, dredged gravel, to be used in filling mill race back of land wall. The crew of the dredge assisted in building cofferdams at Lock No. 1, Barren River, and Lock No. 4, Green River. The dredging at the various locks has been as follows:

Lock No. 1, Green River: Upper entrance, 5,250 cubic yards.

Lock No. 2, Green River: Upper entrance, 11,775 cubic yards; 575 linear feet sunken timber. Lower entrance, 4,165 cubic yards; 1,925 linear feet sunken timber. Lock chamber, 300 cubic yards.

Lock No. 3, Green River: Upper entrance, 1,950 cubic yards; lower entrance, 700 cubic yards; lock chamber, 400 cubic yards.

Lock No. 4, Green River: Upper entrance, 2,500 cubic yards.

Lock No. 1, Barren River: Upper entrance, 1,000 cubic yards; lower entrance, 250 cubic yards; lock chamber, 300 cubic yards.

Lock No. 1, Green River: Cofferdam, 885 cubic yards.

Lock No. 4, Green River: Gravel for filling back of lock wall, 610 cubic yards.

Total, 30,085 cubic yards, 2,500 linear feet sunken timber.

Two new deck barges.—These were needed to transport tools, materials, etc., and to take the place of three old barges that have been practically worn out in service. The barges are 100 feet long, 20 feet wide, 5 feet deep, and are constructed of long-leaf yellow pine, with white-oak streamers, rake frames, and timber heads.

Two new derrick boats.—These were constructed to replace two derrick boats that are practically worn out. They are 70 feet long, 26 feet wide, and 4 feet deep, with masts 40 feet high, supported by 4 timber stiff legs, and having booms 60 feet long. The derrick boats are each operated by a "Mundy" 18-horsepower double-drum hoisting engine, which were taken off the old derrick boats. The engines are protected from the weather by cabins 18 feet square, 10 feet high.

All work has been done by hired labor, excepting the repairs to machinery of snag boat, which were done under ten-day proposals. All materials have been purchased under ten-day proposals, or formal contract, except in a few instances where small purchases were made in open market.

Very respectfully, your obedient servant,

G. F. STICKNEY, *Assistant Engineer.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 10.

IMPROVEMENT OF ROUGH RIVER, KENTUCKY.

[This work was in the charge of Maj. James F. Gregory, Corps of Engineers, until May 14, 1897.]

For full report of project see page 2280, Report of Chief of Engineers for fiscal year ending June 30, 1896.

Operations during the past fiscal year were directed toward the completion of the lock and dam on which work was resumed August 5, 1896. Previous to that date a small force of men was employed at deadening and removing overhanging trees and snags from the banks of the river between the lock site and Hartford, Ky.

The work accomplished during the year includes 12,266 cubic yards earth and mud excavation; 1,820 cubic yards concrete mixed and placed; 2,039 cubic yards earth filling back of land wall; 460 cubic yards grading in vicinity of lock; 2,566 cubic yards stone filling placed in dam and guide cribs; 1,676 cubic yards puddle placed above dam; 172,964 feet B. M. lumber framed and placed in dam and lock gates; 23,543 pounds cast and wrought iron hollow quoins, rods, bolts, valves, etc., placed in lock gates, and 146 linear feet of 12-inch vitrified pipe laid back of land wall.

The erection of an additional cottage for lock tenders is contemplated and provided for in the approved project if found essential, but no further appropriation is at present deemed necessary, either for this purpose or that of removing the snags and other obstructions from the reach of river included within the limits of the project for improvement. The details of operations during the fiscal year are set forth in the reports of Assistant Engineers William M. Hall and G. F. Stickney, submitted herewith.

Money statement.

July 1, 1896, balance unexpended	$48, 355. 90
June 30, 1897, amount expended during fiscal year	35, 593. 46
July 1, 1897, balance unexpended	12, 762. 44
July 1, 1897, outstanding liabilities	102. 60
July 1, 1897, balance available	12, 659. 84

APPROPRIATIONS.

September 19, 1890	$25, 000
July 13, 1892	15, 000
August 17, 1894	22, 500
June 3, 1896	43, 000
Total	105, 500

Commercial statistics, Rough River, Kentucky, from December 12, 1896, to June 30, 1897.

	Tons.		Tons.
Timber, logs, etc	15, 545	Merchandise	401
Beer	20	Salt	19
Cement	1	Ties, railroad	269
Flour	23	Tobacco, leaf	19
Grain	105	Whisky	1
Hay	6	Passengers	2
Hoop-poles	62		
Live stock	42	Total	16, 538
Lumber	23		

Report of lockages on Rough River, Kentucky, for fiscal year ending June 30, 1897.

Lock No. 1:	
Days operated	146
Days suspended	55
Going up—	
Steamboats	36
Barges and flats	10
Going down—	
Steamboats	33
Barges and flats	9
Rafts	136
Total crafts and flats passing	224
Total number of lockages	370

NOTE.—The lock was opened to navigation December 12, 1896, since which date locking was suspended for fifty-five days on account of high water.

List of boats plying on Rough River, Kentucky, during the fiscal year ending June 30, 1897.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Wm. Preston Dixon	United States snag boat.	134.9	32	5	200
Janie Rae	Passenger	110	25.9	3	99.54
Peankishaw	....do	80.9	20.2	3.6	53.18
Lena Archer	Tugboat	45	9	4	8
Three Brothers	Sawmill boat	100	20	2.8	52.80
Sadie	Pleasure boat	31.5	6	4	3
City of Hartford	Gasoline boat	....	....	....	....

REPORT OF MR. WILLIAM M. HALL, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Bowling Green, Ky., June 30, 1897.

CAPTAIN: I have the honor to submit the following report upon the improvement of Rough River, Kentucky, for period ending December 31, 1896:

By act of June 3, 1896, $43,000 was appropriated for the completion of the lock and dam commenced April 29, 1895, and for clearing the river of obstructions to Hartford, Ky., 23 miles above the lock.

It was then decided to try and complete the lock, dam, and other necessary work for opening the river for navigation to Hartford before the end of the season. Therefore, as stated in my last annual report, on June 15 a force, consisting of about 18 men, commenced work near the lock site at clearing the river of snags, logs, drift, and overhanging trees, proceeding upstream with the work.

But operations on the lock were delayed in consequence of instructions that the appropriation of June 3 was not to be drawn upon until further authority. Such authority was received on July 14, and active preparations were promptly commenced for the resumption of construction of lock and dam.

Work of construction was resumed upon the lock on August 5. On that date the condition of the work was as follows:

The plant, tools, and concrete form timbers, used during the preceding season, were stored at lock site; the buildings were in good order; the cofferdam and wharf were intact and without serious injury from preceding winter floods; the masonry for river wall of lock and abutment for dam was complete and in excellent condition.

The total expenses for the season's work from July 1, 1896, to December 31, 1896, are in detail as follows:

Material for concrete	$7,849.63
Labor mixing and placing concrete	2,556.48
Labor erecting and removing temporary trestles	150.00
Material for concrete forms	334.38
Labor framing, erecting, and removing concrete forms	2,326.08
Material for buildings	419.75
Labor erecting buildings	278.90
Plant:	
Small tools	409.05
Excavating and clearing river channel below lock	77.95
Excavation of lock and abutment pits	1,231.80
Material for guide cribs	1,053.64
Labor erecting guide cribs	1,570.80
Grading lock grounds and filling behind land wall and land cribs	905.33
Material for lock gates	1,321.32
Labor framing and erecting lock gates	1,185.70
Material for dam	2,485.30
Labor framing and erecting dam	1,583.00
Excavation for dam	861.00
Puddling dam	343.00
Excavation for upper approach to lock	450,45
Excavation for lower approach to lock	253.33
Quarrying, boating, and placing stone filling for dam	1,752.44
Quarrying, boating, and placing stone filling for guide cribs	625.80
Storing and watching plant	766.93
Drain pipe back of land wall	123.95
Removal of plant from lock site	643.06
Miscellaneous	2,441.69
Clearing river of snags, etc., and cutting overhanging trees from lock to Hartford, 33 miles	1,888.87
Total	35,889.61

By combining the totals of above with corresponding totals shown in my annual report of June 30, 1896, of work done to that date, the following statement of the entire cost of the work is obtained:

	Total expenses 1895-96.	On hand and serviceable.	Used in the work.
Material for concrete	$24,613.78	$398.50	$24,215.28
Labor mixing and placing concrete	5,284.46	....	5,284.48
Materials for trestle and wharf	721.53	75.00	646.53
Labor erecting and removing trestle	837.34	....	837.34
Material for concrete forms	3,334.12	750.00	2,584.12
Labor framing concrete forms Labor erecting and removing concrete forms	4,675.56	....	4,675.56
Material for buildings	1,611.62	150.00	1,461.62
Labor erecting buildings	993.68	....	993.68
Plant:			
Machinery	7,644.05	6,000.00	7,644.05
Small tools	1,377.59	600.00	777.59
Excavating and clearing river channel below lock	761.38	....	761.38
Excavation of lock and abutment pits	5,030.02	....	5,030.02
Material for cofferdam	1,129.72	....	1,129.72
Labor framing and placing cofferdam	650.00	....	650.00
Labor puddling cofferdam	223.57	....	223.57
Material for breakwater	19.56	....	19.56
Labor erecting breakwater	80.80	....	80.80
Material for guide cribs	1,053.64	....	1,053.64
Labor erecting guide cribs	1,570.80	1,570.80	1,570.80
Grading about land wall	1,248.33	1,248.33	1,248.33
Grading about abutment	297.75	....	297.75
Removing old lock wall	324.85	....	324.85
Material for lock gates	1,321.32	....	1,321.32
Excavation of dam	861.00	....	861.00
Excavation for upper approach to lock	450.45	....	450.45
Excavation for lower approach to lock	253.33	....	253.33
Quarrying, boating, and placing stone filling for dam	1,752.44	....	1,752.44
Quarrying, boating, and placing stone for guide cribs	625.80	....	625.80
Drainpipe back of land wall	123.95	....	123.95
Storing and watching plant	969.29	....	969.29
Removal of plant from lock site	643.03	....	643.03
Miscellaneous	4,221.06	....	4,221.06
Clearing river of snags, etc., and cutting overhanging trees from lock to Hartford, 23 miles	1,888.87	....	1,888.87
Total	82,048.72	7,978.50	74,075.22

By deducting amount for clearing river from this statement it will be observed that the lock, dam, abutment, and all auxiliary parts, including grading grounds and erecting lock-hand's dwelling, cost $72,186.35.

The quantities of work accomplished are shown in detail in the table following. The quantities shown as done previous to June 30, 1896, are the same as shown in my last annual report.

		Prior to June 30, 1896.	Subsequent to June 30, 1896.	Total.
Excavated from channel:				
Clay	cubic yards	3,160	303	3,463
Stone	do	....	6	6
Excavated below lock	snags	232	....	232
Excavated from lower approach to lock	cubic yards	580	2,030	2,610
	snags	33	....	33
Excavated for lock walls and abutment:				
Above water	cubic yards	9,174	1,600	10,774
Below water	do	4,965	1,703	6,668
Removal of river wall of old lock (clay, stone, timber, iron)	do	1,500	....	1,500
Cofferdam for lock in place:				
Timber	feet B. M	98,000	....	98,000
Puddle	cubic yards	2,147	....	2,147
Concrete mixed and placed	do	1,860	1,820	3,680
Breakwater:				
Timber	feet B. M	12,000	....	12,000
Stone filling	cubic yards	169	....	169
Fill back of land wall	do	....	2,031	2,031
Grading lock grounds	do	....	460	460
Excavation for dam	do	....	3,800	3,800
Excavation for upper approach to lock and upper guide cribs	do	....	2,794	2,794
Timber in dam	feet B. M	....	164.530	164,530
Stone filling in dam	cubic yards	....	1,676	1,676
Puddle placed above dam	do	....	1,718	1,718
Timber in guide cribs	feet B. M	....	66,349	66,349

	Prior to June 30, 1896.	Subsequent to June 30, 1896.	Total.
Stone filling in guide cribs .... cubic yards..	....	890	890
12-inch vitrified pipe back of land wall .... linear feet..	....	146	146
Timber in gates .... feet B. M..	....	8,434	8,434
Iron in gates:			
Cast .... pounds..	....	14,165	14,165
Wrought .... do...	....	9,378	9.378

From the details mentioned in the above statements the total cost of the 3,680 cubic yards of concrete used in this work, and per cubic yard, is as follows:

Itemized cost of 3,680 cubic yards of concrete.

		Prior to June 30, 1896.	Subsequent to June 30, 1896.	Total.
5,339 barrels cement:				
2,189 barrels, at $3.36½	$7,365.98..	$9,633.68	$7,147.45	$16,780.48
1,100 barrels, at $3.00½	3,305.50..			
2,050 barrels, at $2.98	6,109.00..			
1,676.7 cubic yards broken stone, at $2.22		1,844.15	1,878.12	3,722.27
1,043 cubic yards gravel:				
719 cubic yards, at $1.39	$999.41..	801.34	661.39	1,462.73
324 cubic yards, at $1.43	463.32..			
1,065.2 cubic yards sand:				
967.2 cubic yards, at $1.22	1,179.98..	817.64	499.54	1,317.18
98 cubic yards, at $1.40	137.20..			
20 per cent (for each year) of cost of timber and framing same for forms		827.95	827.95	1,655.90
Total cost of materials		13,924.11	11,014.45	24,938.56
Labor, erecting and removing forms		1,209.48	2,326.08	3,535.56
25 per cent (for each year) of timber and iron for approach trestles to forms		75.00	75.00	150.00
Labor, erecting and removing same		200.00	150.00	350.00
20 per cent (for each year) of cost of buildings		381.26	381.26	762.52
10 per cent (for each year) of cost of plant		861.33	861.33	1,722.66
50 per cent (for each year) of cost of erecting mixer plant		62.28	62.28	124.56
Labor, mixing and placing concrete		2,728.00	2,556.46	5,284.46
Total		19,441.46	17,426.86	36,868.32

The quality of the sand, gravel, and stone used in making concrete was the same as described in my last annual report of June 30, 1896, and the mixtures the same, viz: The facing, 1 part of cement to 2 parts of sand; and the concrete, 1 part of cement to 2 parts of sand, to 2 parts of gravel, to 3 parts of broken stone.

In mixing and placing the concrete the same general rules and methods were observed as described in that report. However, the average thickness of mortar facing on land wall was made about 3½ inches instead of 6 inches, and no facing was put on surfaces not exposed to view. This change resulted in a material saving of cement.

In mixing, the cubical mixer was revolved with each batch of material from fifteen to eighteen times, which I am satisfied resulted in a better quality of concrete than by revolving only nine times, as was the rule during the season of 1895.

In erection of land wall, the wall and two wings were constructed in ten sections. The form from end to end of wall was erected and all the sheeting put on face before commencing the placing of concrete. By so doing a plane surface was obtained for face of wall without apparent defect.

The training given employees in placing concrete during the season of 1895 and some improvement in organization enabled us to place the ten sections of land wall with rapidity and ease.

There were 1,860 cubic yards of concrete placed in 1895 and 1,820 cubic yards in 1896.

From this statement we observe that the concrete placed in 1895 cost $10.45 per cubic yard, that placed in 1896 cost $9.55 per cubic yard, and that the cost as a whole was $10.02 per cubic yard, $6.78 of which was for materials.

It may be added that the price for cement was the cost in storehouse at lock, and the above statement of cost of concrete includes due allowance for superintendence, temporary buildings, storage, plant, tools, etc.

The excess in cost of land wall and abutment, built in 1895, was due to the fact that 6 inches of mortar facing was put on face and back of river wall and that a bridgeway was built across the river for transporting concrete to abutment, whereas on the land wall an average of only 3¼ inches of facing was put on face of wall and none on the back.

The cost of other classes of work in detail are as follows:

Cofferdam timber in place	per M feet B. M.	$17.14
Timber in dam in place	do	24.71
Stone filling in dam in place	per cubic yard	1.04
Timber in guide cribs in place	per M feet B. M.	39.55
Stone filling in guide cribs in place	per cubic yard	.70
Four gates in place	each	626.75
Clearing river of overhanging trees, snags, logs, etc., 23 miles	per mile	82.12

The quantities of work accomplished are shown in above tabulated statements, but, in short, the work was done as follows:

The river was cleared of trees, snags, etc., to Hartford; the old lock walls removed; the lock walls and abutments for dam for new lock built of concrete masonry; the dam built of timber and filled with stone; guide cribs built above and below lock; gates erected; approaches to lock excavated; lock grounds graded; lock-hand's house, tool house, and storehouse erected; and all other necessary work done for the opening of the lock and river for navigation to Hartford, 30 miles from mouth of river.

The only remaining work to be done and provided for in original project, is the deepening of channel for about 400 feet below the lock, the erection of a crib to protect river shore below abutment, the erection of lock-master's dwelling, digging well, the fencing of lock grounds, and the cutting of a few more overhanging trees on upper part of river.

The lock and river were opened for navigation on December 12, 1896, with a minimum depth of about 4 feet at pool stage from mouth of river to Hartford, except on Rock Shoal, just below lock, where the depth is only about 3 feet 3 inches.

Respectfully submitted.

Wm. M. Hall, *Assistant Engineer.*

Capt. J. G. Warren, *Corps of Engineers.*

REPORT OF MR. G. F. STICKNEY, ASSISTANT ENGINEER.

United States Engineer Office,
Bowling Green, Ky., June 30, 1897.

Captain: I have the honor to submit the following report of operations pertaining to improving Rough River, Kentucky, for the fiscal year ending June 30, 1897. The construction of the lock was completed, and the lock was opened to navigation December 12, 1896. Mr. William M. Hall, assistant engineer, was in local charge until December 21, 1896, and on that date the work was placed in my charge.

Since the lock opened there has been one passenger boat running on the river with tolerable regularity, excepting during the month of February and part of the month of March. The only work done, other than operating the lock, is as follows:

Graded the Government land; planted 53 shade trees, and sowed the land immediately back of the lock in clover seed; quarried 75 cubic yards of stone, and placed 150 cubic yards of stone below abutment to prevent water from cutting out the bank; constructed well, lined with stone, 22 feet deep, 4 feet in diameter inside of lining; built a small cellar in the hillside, and partially lined same with stone; painted the lock house and both sets of lock gates.

Very respectfully, your obedient servant,

G. F. Stickney, *Assistant Engineer.*

Capt. J. G. Warren, *Corps of Engineers.*

E E 11.

PRELIMINARY EXAMINATION OF TREADWATER (TRADEWATER) RIVER, KENTUCKY.

[Printed in House Doc. No. 4, Fifty-fifth Congress, first session.]

Office of the Chief of Engineers,
United States Army,
Washington, D. C., March 10, 1897.

Sir: I have the honor to submit the accompanying copy of report, dated February 9, 1897, with map,* by Maj. James F. Gregory, Corps of Engineers, of the results of a preliminary examination of Treadwater (Tradewater) River, Kentucky, made in compliance with the provisions of the river and harbor act of June 3, 1896.

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* Not reprinted; printed in House Doc. No. 4, Fifty-fifth Congress, first session.

Tradewater River has been under improvement by the United States since 1881, the approved project providing for clearing the river and its banks of obstructions, and opening a channel 40 feet wide and 2½ feet deep during six months of the year from its mouth in the Ohio River, 41 miles upstream.

For the reasons given, it is the opinion of Major Gregory, which is concurred in by the Division Engineer, Col. Henry M. Robert, Corps of Engineers, and by me, that Tradewater River is not worthy of improvement by the General Government beyond the present approved project of keeping the channel free from snags and other obstructions.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, February 9, 1897.

GENERAL: In compliance with letters dated Office Chief of Engineers, United States Army, June 16, 1896, and August 11, 1896, I have the honor to submit the following report of preliminary examination of Treadwater (Tradewater) River, Kentucky, provided for in the river and harbor act of June 3, 1896:

In compliance with the provisions of the river and harbor act of June 14, 1880, an examination and survey of the Tradewater River was reported upon (with maps) by Capt. James W. Cuyler, Corps of Engineers, June 21, 1881, and to that report (see Annual Report, Chief of Engineers, 1881, pp. 1991 to 1994) and to Major Cuyler's annual report upon the improvement of Tradewater River, Kentucky, dated August 19, 1882 (see Annual Report, Chief of Engineers, U. S. A., 1882, part 3, pp. 1959 to 1963), reference is particularly invited for description of the river and the tributary country. The physical characteristics of the river are fully described in Major Cuyler's reports, and the conditions relating to its improvement have only changed by the present existence of additional facilities for transportation of agricultural and other products of the country, including coal, by the construction of railroads.

In November, 1896, Mr. D. A. Watt, civil engineer, under my direction, made an examination of the river from Dawson, on the upper Tradewater, to its mouth, and in December of the same year I examined it in the vicinity of Sturgis and Commercial Point, where are located the principal coal mines, and the only ones now being worked. Mr. Watt's very full and descriptive report is appended hereto and reference is invited to it for details and statistics.

In Captain Cuyler's report consideration is given to the construction of three small locks and dams, the former to be 125 feet long by 20 feet wide, with a lift of 10 feet each, and designed for a 4-foot navigation, at an estimated cost of $118,000. Such locks and such depth of navigable river would be of no value whatever to the coal interests, and the present facilities for railroad transportation are such that an expenditure of probably $250,000, instead of $118,000, which would be required for the construction of said three locks and dams, is not warranted by either the present or prospective output of the country tributary to the river.

The Tradewater region is undoubtedly rich in coal, and it is said to be of a quality equal to the best Pittsburg coal. If it were possible to make the river a channel way for coal commerce, the development of mines would doubtless take place immediately. The Cumberland Coal Company, of Nashville, Tenn., have large coal properties all along the river and on both sides of it, and are at present operating one mine from a drift heading at Sturgis, the output of which is from 500 to 800 tons per day. The Tradewater coal mines at Sturgis are also working with a lesser output, from a shaft about 180 feet deep, and these are, I believe, the only mines now in operation.

The Cumberland Company have constructed and operate a railroad from their mine to the Ohio River, a distance of about 4½ miles, but their shipments, nevertheless, are almost entirely by rail, their own railroad being a guaranty against excessive freight rates.

If there were one lock and dam near the mouth of the river, so as to provide a pool for storage of coal fleets, which could go out at convenient stages of water, it would contribute greatly to the interests of coal production, especially as there is no harbor for coal boats in the Ohio River near the mouth of the Tradewater. But to be of any very great service a lock should be of dimensions sufficient to pass the largest barges and floats used in the coal trade, because small ones are not economical and could not compete with fleets carrying barges of larger capacity.

Mr. Isaac Reese, secretary and treasurer of the Cumberland Coal Company, in a letter to me of December 14, 1896 (copy appended), says:

> While our company is interested more than anyone else in getting locks and dams in Tradewater, I do not think that small locks will be of any value. They should not be less than 60 by 140 feet, and ought to be larger than this.

The Tradewater is a small and very crooked river. Its width in the vicinity of Sturgis is only about from 110 feet to 130 feet at what would be pool level. At high water it is not much wider, as the banks are steep, and at dead low water one can walk across it in many places near Sturgis almost, if not quite, dry-shod. Two coal barges could not be alongside each other at any stage of water without obstructing navigation, nor could one or any steam towboat, such as is used in the coal traffic, be turned around in the river. It would be enormously expensive to build a lock of the size required, as it would have to be built in the bank in order not to obstruct the river. The greatest obstacle to such improvement, however, is the limited supply of water. At ordinary low water it would take two hours or more to supply a single lockage, and at mean water it is more than doubtful if the flow could supply water enough to keep the lock in operation, and at dead low water there would, of course, be no water for lockages.

In my opinion the Tradewater River is not worthy of improvement by the General Government beyond the present approved project of keeping the channel free from snags and other obstructions, for reasons as follows:

Above Bellville the stream is too small and crooked to be given consideration. Below Bellville the river is now practically clear during navigable stages of water, and as commerce has practically left it because of railway facilities and low-water seasons, there is no justification for expensive improvements.

While it is no doubt feasible to construct, near the mouth, a lock large enough to pass a coal barge, the important question at once arises: Would there be sufficient water in the river to supply it? For a considerable portion of the year this may at once be answered in the negative. For how long a period of each season of navigation there would be sufficient river flow for lockages can only be determined by gauging the river at varying stages of water.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, March 2, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with Major Gregory in the opinion that the Treadwater (Tradewater) River, Kentucky, is not worthy of being improved by the General Government beyond the present approved project.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. D. A. WATT, CIVIL ENGINEER.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, December 14, 1896.

MAJOR: I have the honor to submit the following report of an examination of the Tradewater River, made on November 6 to 11, 1896, under verbal instructions received from you on October 31, 1896:

This river rises in Christian County, western Kentucky, and flows northwest to the Ohio, emptying into it 2¼ miles below Caseyville, Union County, Ky., and about 105 miles above Cairo, Ill. Its basin, which occupies the area between the Green and Cumberland rivers, measures, approximately, 60 miles in length by 20 miles in breadth, and has an area of about 830 square miles.

The first examination of the Tradewater River under the General Government was made in 1880, under the direction of Capt. James W. Cuyler, Corps of Engineers, U. S. A. His report (published in the Annual Report of the Chief of Engineers, United States Army, for 1881, pages 1991 to 1994, inclusive) recommended the clearing of the river of snags, etc., for a distance of 41¼ miles from its mouth, and the subsequent introduction of slack-water navigation by means of three small locks and dams. The first part of this project having been approved, a first appropriation of $3,000 was made in March, 1881, and work was commenced in August of the same year, with the object of removing all obstructions to traffic. From that time until August, 1888, a total amount of $16,500 was appropriated, and the first part of the project was practically completed in December, 1890. The river had then been cleared as far as Bellville, a ford situated about 3 miles from Providence, and a distance of 41¼ miles from the mouth. No further work has been done since then, nor any money spent upon improvements.

The present examination was called for by the act of June 3, 1896, which directed an examination to determine the advisability of further improvements. It was commenced at Dawson, on the upper Tradewater, and continued down the river to its mouth.

Between Dawson and Providence, about 25 miles by road, the river is very small and crooked, and impassable with snags, and the country is sparsely settled. There is still a quantity of good timber in the bottoms and along the creeks at some distance from the river, but the general conditions are such as to render very unadvisable any clearing of the river above Bellville. The improved portion of the river below this point is still in excellent condition, and though some snags have come into the channel and one or two dams have been constructed, they do not interfere with boats when the water is at a navigable stage. Good timber in this district has become scarce, and the country here is much more settled, especially below Blackford. The width of the river at low water at Bellville would be from 25 to 35 feet, and at mean water from 40 to 60 feet.

The general improvement carried out by the United States proved for some years of great benefit and resulted in a large increase of traffic. Since 1891, however, this commerce has gradually decreased, owing to its diversion to the railways and to the unreliability of navigation. At the time of the first examination (1880) the Tradewater was the only means of communication, but between 1884 and 1887 a branch of the Louisville and Nashville Railway was opened to Providence and the construction finished of the Ohio Valley Railway. The latter parallels the river on the east side at a distance nowhere exceeding 2 miles as far as Blackford, where it crosses and leaves the stream. From here to Providence is 13 miles by road, so that the district is now well provided with communication, and as the natural result its commerce has been absorbed by these two railways. The lumber interest is at present the only one of importance upon the river, but owing to dry seasons no timber has been run for nearly two years, and the sawmills are lying idle. At times, however, the depth of water is more than sufficient, as flood marks were visible on trees in the bottoms (at present dry) from 5 to 8 feet above the ground. These floods are produced by the backwater of the Ohio River.

Commercial statistics for the past year were not obtainable, as during that period steamers have only made occasional trips, and have not gone farther than Blackford, 20 miles from the Ohio. The last statistics of value are to be found in the Annual Report of the Chief of Engineers, United States Army, for 1891, Appendix J J, page 2438, and illustrate the fluctuating character of the traffic.

The merchants and inhabitants generally expressed the belief that slack-water navigation would still be of great benefit to the community in developing resources and cheapening freight rates. It was stated at Providence that the opening of the river to Bellville in 1890 resulted in an immediate decrease of railway tariffs, but that since the stage of water became unreliable they have been restored.

The following statistics of shipments from this point during the past year were supplied by the Providence Banking Company, who expressed their belief that a large part of the traffic would have been taken to the river if it had been slack watered:

Lumber, feet, B. M., 2,000,000; coal, tons, 250,000; tobacco, hogsheads, 3,500; live stock, cars, 250; grain, mill stuffs, and general merchandise to the value of $550,000.

While such an improvement would undoubtedly be of benefit, the following must be considered in connection with the subject:

The timber business is of a temporary nature, and as it requires good water it must always be dependent on floods rather than on pools, which are most useful in ordinary stages. In other words, the lumber will find its outlet in any case in the natural course of time.

The coal traffic might to some extent be taken by water and possibly new mines opened, but owing to the smallness and crookedness of the stream only one barge could be taken down the river at a time. This would effectually preclude any cheap delivery. Moreover, as coal is as abundant in the lower as in the upper districts, the mines on the lowest pool would be worked to the exclusion of those on the pools above. The freer navigation during floods would not be of much assistance, as in high water the channel is still crooked and narrow, while the raising of the water level by the dams would result in frequent flooding of the bottoms.

In addition to this the river should be available to navigation at all seasons, or at least for the greater portion of the year, and owing to the small flow of water a dry season would seriously impede the traffic. There is always some supply of water, as it is said that springs exist throughout the basin, but in dry weather it becomes so small that the amount would barely suffice for two or three lockages a day. The Annual Report of the Chief of Engineers, United States Army, for 1882, Appendix Z, page 1963, gives the minimum discharge near the mouth as 11.2 cubic feet per second, an amount which would of course be less on the upper river. That season, however, was said to have been exceptionally dry.

It appears, then, that the only commerce which would be permanently benefited by slack watering the Tradewater would be that of agricultural and general products. Three locks and dams as proposed would hardly cost less than $250,000, while the average yearly charges for operation and repairs may be taken at $3,500 per lock, or $10,500 for the three. Neglecting the cost of construction, the general benefit to the community, which in this case would mean little more than a saving in freight rates, should, therefore, be not less than $10,500 a year. It is difficult to see where such a saving could occur, as in any case a large amount of freight would still be shipped by rail.

As regards the lower portion of the Tradewater, the inhabitants of the country adjacent to the mouth are desirous of having one lock and dam placed there with the view of reopening the former coal traffic. This district is also well provided with communication, and under ordinary conditions construction with such an object on so small a stream would appear most injudicious. In view of past experience, however, the matter is at least deserving of consideration.

This river is the most westerly one intersecting the Kentucky coal fields, and the product is said to be equal in quality to that of the Pittsburg district, and superior to any mined below the Big Sandy River. As the coal extends down to the Ohio and lies close to and on both sides of the stream, there are unusual advantages for cheap water shipment to southern points. The veins are three in number, and possess a thickness of 5 to 5½ feet.

Coal mining in this region was carried on prior to 1860 by Governor John Bell, of Tennessee, and also by Messrs. Casey, the coal being shipped down the Tradewater into the Ohio. Their mines were on the banks of the river, about 2 miles above its mouth. The industry since that time was continued as the stages of water would permit, and after the improvement of the river by the United States the output was greatly increased—that of 1889, as given by the commercial statistics, being 30,000 tons, or 65 standard barge loads. A succession of low-water seasons, however, resulted in closing these mines, and out of 12 or more which were in operation at that time on both sides of the river, only 2 are now worked. These are at Sturgis, on the Ohio Valley Railway, and their shafts are adjacent to the tracks and about half a mile from the Tradewater. One is worked from a drift heading; the other from a shaft about 185 feet deep. Each company has recently put in new machinery, while one of them—the Cumberland Coal Company—has constructed a railway 4½ miles to the Ohio, at a cost of $30,000, for the sake of obtaining shipment by water. Their combined output is expected to reach from 50 to 70 carloads a day, and while these figures are possibly too sanguine, the industry will no doubt be further developed. At Dekoven, a few miles farther along the railway, a large amount of mining is also done; at Providence it is the same; and elsewhere through the valley of the Tradewater these coal veins have proved their great commercial value.

The question at issue may then be stated thus: Whether, in view of the river being small and of there being railway transportation, a coal traffic could be established of enough extent and at a saving of carriage sufficient to justify the construction of a lock and dam?

An assumed lift of 10 feet above low water would give a pool of about 11 miles with a depth of 3½ feet at the upper limit, a minimum depth below Commercial of 9 feet, and a depth over the Commercial Ripple of about 7 feet, and would probably correspond to a depth of 10 feet in the Ohio outside. (These figures are taken from the map of the survey of 1880, and are approximate only.) Such a pool would reach all the coal traffic the river could take. The size of the lock could be sufficient to accommodate only one barge at a time. At pool level the stream would probably be from 110 to 130 feet wide, so that two barges could hardly be moored abreast without interfering with the traffic. Most of this width, however, would be available, as the banks slope about 45 degrees, and would thus permit barges to lie close against the edge. At Commercial the first ripple occurs, and below that there would be a depth of 9 to 25 feet. At the time of this examination the depth was from 5 to 15 feet and over, and was found to be less in one or two places only. The stage of the Ohio channel just outside was then mean 5½ feet. In this portion of the river there is only one really difficult bend, and it lies about 1,100 yards above the rock bar near the mouth. No steamer could pass it with more than two barges at a time, and even then, though the water is deep, they would require careful handling. Any current in the stream would of course increase the risk. This curve could be flattened without great expense, but that would be a matter for later consideration.

With regard to the bar at the mouth in the Ohio, referred to in the Annual Report for 1882, Appendix Z, pages 1960 to 1963, inclusive, no recent map exists to show its present condition. It is reasonable to assume, however, seeing that a spur dike was built out in 1893 from the Illinois shore directly opposite, that a mean 6-foot stage in the Ohio channel would enable boats to pass in and out of the river. (See the Annual Report for 1894, part 3, p. 1840, and for 1895, part 3, p. 2330.)

A coal traffic on the Tradewater, to be of any extent, would of necessity depend upon backwater from the Ohio. This would follow in the first case from the small low-water flow, which could not be relied on with safety to do much beyond keeping the pool full, and in the second case from the size of the lock, which, being only of a one-barge capacity, would be of small assistance in passing a run of coal.

Assuming, then, a pool level of 10 feet, a backwater height of 10 feet would be necessary for free navigation through the lock and a height of 17 feet for navigation over a fixed dam for barges of 6½ feet draft. No other type of dam would be permissible, as the supply of water would frequently be insufficient to supply the leakage of a movable dam.

The number of days on which these heights have occurred between 1885 and 1892 is as follows:

Year.	Days below 10 feet.	Days above 10 feet.	Days above 17 feet.
1885	145	220	75
1886	137	228	124
1887	201	164	94
1888	112	254	123
1889	62	303	113
1890	63	302	201
1891	163	202	128
1892	154	212	153
Total, eight years	1,037	1,885	1,011
Average, year	129	236	126

These figures are from readings on the gauge at Evansville, Ind., 80 miles above the Tradewater. No connection could be obtained between the zero heights of these two places, but as a reading of 6 feet on the gauge corresponds to 6 feet in the channel, we may reasonably assume their conditions to be alike.

Deducting, say, thirty days for obstructions by ice, etc., there would remain during each year an average of ninety-six days of free navigation over the dam and two hundred and six days of free navigation through the lock, during which periods barges could be transferred to and from the Ohio.

Coming now to the question of freight rates, it has been found very difficult to establish an impartial comparison of railway and river charges. There has been a steady decline of railway tariffs for many years, and the charge of three-fourths cent per ton per mile, which was formerly considered very low, is now common on all roads where there is any competition. The Chesapeake and Ohio Railway, which comes into direct competition with the Ohio River, has recently put into effect a tariff on coal of 75 cents per ton from the Great Kanawha mines to Cincinnati, 240 miles, equivalent to about three-tenths cent per ton per mile. The rate for water transportation for the same distance is 37½ cents per ton, or exactly one-half, and this has remained almost unchanged for fifteen years.

As the output of the Tradewater would be limited, it would probably seek the nearest markets, which would be about 100 miles in either direction, or from Cairo to Evansville. Some of this coal is now shipped to St. Louis and to Louisville, but at each point there is an increasing competition with coal produced from mines nearer these markets, and which may eventually shut out the Tradewater coal. Taking, then, 100 miles as a rough basis of comparison, I am informed that water transportation for this distance, including the hire of the barges, would amount to about 30 cents per ton. Railway transportation for the same distance (assuming a probable mean of the rates before quoted) may be taken at 50 cents per ton (five-tenths cent per ton per mile), a difference of 20 cents per ton in favor of the river. A longer haul would of course increase this difference.

If, now, we assume the average yearly charge of the lock to be $5,000, to include all expenses of operation, repairs, and dredging, the shipment of coal must be at least $\frac{\$5,000}{\$0.20}$, or 25,000 tons per annum, in order that the freight saved to the community may be equal to the expense of maintenance. This takes no account of interest on the cost of construction.

This is equivalent to about 54 standard barge loads, which would have an average of two hundred and six days per annum in which to enter and leave the river without obstruction. This amount was exceeded by 5,000 tons in 1889, when the shipments by river before alluded to amounted to 30,000 tons. It thus appears that under a continuance of present tariffs a coal traffic could be established sufficient to repay the construction of a lock and dam.

The decline of railway charges, however, shows no sign of abatement, and while water carriage must always be the cheaper, the ratio may become such that a sufficient traffic could not find place upon the Tradewater to compensate the annual charges of the lock. In any case some years must elapse before a traffic could be established, during which time a readjustment of rates would have taken place. The situation is influenced again by the gradual changing of the coal markets of the Southern States, as the opening of their deposits, in some cases with facilities for shipment to and on the Mississippi and other rivers, is creating there a decided change in the status of this commerce. Lastly, though the possibility may be too remote to influence this question now, an extension of slack water on the Ohio below the Tradewater would render a lock and dam unnecessary, as with tramways the coal could be loaded direct on the main river.

I may add that the foregoing statements are gathered from information supplied not only by the inhabitants of the Tradewater district, but also from many of the coal merchants, towboat owners, and steamboat captains of this city.

A map of the district is appended hereto, and a map of the river is to be found on the tracings in this office, made from the survey of 1880.

Very respectfully, your obedient servant,

D. A. WATT, *Civil Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

LETTER OF SECRETARY OF CUMBERLAND COAL COMPANY.

NASHVILLE, TENN., *December 14, 1896.*

DEAR SIR: Referring to our conversation at Sturgis, Ky., in reference to the feasibility of placing locks and dams in Tradewater River, I do not think the locks would be of any special commercial value outside of bringing coal to the Ohio River. Our coal property lies on each side of Tradewater River and comprises 7,000 acres. Coal of the finest quality could be mined on each side of the river for 50 miles or more from its mouth. The field is inexhaustible, and if there is sufficient water in Tradewater River to supply the number of locks that would be required, then the coal field adjacent to Tradewater River will become of greater commercial value than the coal fields along the Monongahela River. The coal is equal in quality to Pittsburg coal and in as great quantity.

The coal field along Tradewater River has an advantage of 1,200 miles nearer than Pittsburg to New Orleans. Not only this great distance can be saved in towing coal to New Orleans, but the Ohio River from the mouth of Tradewater down is very good navigation. It is below all the bad obstructions and is almost free from ice.

The present consumption of coal in New Orleans and vicinity amounts to about 3,000,000 tons. From present rate of increase this large consumption will be doubled in a few years, as New Orleans is destined to become one of our largest export ports. Last year 3,000,000 bushels of grain was exported from New Orleans; this year over 22,000,000 bushels. This will give you an idea of the rapid increase New Orleans is making. The Mississippi River makes New Orleans the most accessible port for grain, tobacco, and cotton. This large export business will tend to make New Orleans one of our largest import ports. Steamers handling this large business must have coal. The coal field adjacent to Tradewater River is the most accessible, as it is the only coal that can reach New Orleans all water haul except Pittsburg.

While our company is interested more than anyone else in getting locks and dams in Tradewater, I do not think small locks will be of any value. They should not be less than 60 by 140 feet, and ought to be larger than this. I am compelled to admit I do not think Tradewater River will furnish sufficient water for the above size locks.

If you desire any further information, I will cheerfully furnish same if in my power.

Very respectfully,

ISAAC REESE,
Secretary Cumberland Coal Company.

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

E E 12.

SURVEY OF WHITE RIVER, INDIANA.

[Printed in House Doc. No. 47, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: The river and harbor act of August 17, 1894, contained an appropriation for continuing improvement of White River, Indiana, "including a resurvey of said river." The survey thus provided for was assigned to the charge of Capt. James G. Warren, Corps of Engineers, and I have now the honor to submit the accompanying copy of that officer's report of May 13, 1896, on the subject.

The present survey has been made to cover the White River proper from its mouth to the junction of the two forks, 48 miles; East Fork from its junction with the West Fork to Portersville, 20¾ miles, and West Fork from its junction with East Fork to the Baltimore and Ohio Southwestern Railway Company's bridge, 14 miles.

The project presented by Captain Warren proposes extension of 3-foot depth now existing in the lower 13 miles of the river to Blackburn Station, 46 miles above mouth of the river; improvement of the East Fork so as to afford a depth limited to 2 feet, and improvement of West Fork to be effected by the use of locks and dams, three of which would be required to give a low-water depth of 2 feet to the Falls.

The estimated cost of the work mentioned is given by Captain Warren as follows:

Main River	$112,859
East Fork	107,118
West Fork	330,000
Total	549,977

In regard to the locks and dams proposed for the West Fork, Captain Warren states that further examination will be required for their location, but by the location of one of them at or near Rocky Ford Ripple, 42½ miles from the mouth of White River, certain of the regulation works for the East Fork would be rendered superfluous and the estimate diminished correspondingly, making the total estimated cost of the improvement $465,946.

In addition to this the caving of unstable banks would render necessary an annual expenditure for snagging and dredging of at least $6,000, or an expensive system of bank protection.

He further remarks:

> These figures, taken in connection with the correspondence (appended) with many prominent citizens of the locality, indicate that the cost of the improvement is far in excess of what would be justified by the present demands of commerce; the future demands will, in my opinion, be dependent upon the commercial effect of the prospective improvement of the Wabash River. At present that stream affords no outlet for the produce of the White River, excepting at high stages of water, and has no commerce of its own. The navigation of this stream, as on the White River, is only by a few small light-draft steamers and barges, which at favorable seasons take grain and produce from the farms adjacent to the river banks for delivery to the nearest railroad.
>
> In view of the above, it is respectfully submitted that the improvement of White River, Indiana, should be suspended until the navigation of the Wabash has been so improved as to afford an outlet for any traffic which may then be developed on White River.

Col. H. M. Robert, Corps of Engineers, the division engineer, in forwarding this report, states as follows:

> I concur in the opinion of Captain Warren that there is nothing now to justify the large expenditure necessary to improve the White River, as its use would be prevented by the condition of Wabash River, and that the further improvement of the White River should be postponed until the improvement of the Wabash has been so improved as to afford an outlet for any traffic which may then be developed on White River.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

HON. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., May 13, 1896.

GENERAL: I have the honor to submit the following report upon the resurvey of the White River, Indiana, made in compliance with the requirements of the river and harbor act of August 17, 1894, and under the project approved by the Chief of Engineers, United States Army, August 28, 1894.

The work of making this survey was deferred in the interest of other and more important matters until October 29, 1895, when a party was put in the field in charge of Mr. Thomas P. Shanks, assistant engineer, to whose report, appended, reference is respectfully made for details.

The White River, wholly within the State of Indiana, is formed near Petersburg, Ind., by the junction of what are known as the East and West forks, and flows thence in a southwestwardly direction 48 miles to the Wabash River, into which it empties opposite Mount Carmel, Ill., which is about 90 miles above the point at which the Wabash discharges into the Ohio.

The improvement of the White River was undertaken by the United States in 1879. No detailed project for the work was then made, nor has all of that portion of the river under improvement been accurately surveyed until the present.

The work of improvement has heretofore been carried on under expenditure projects, based in part upon a rough examination made in 1878, and in part upon an instrumental survey of the lower 18 miles of the river made in 1879 and 1880.

This work has consisted in the removal of the worst obstructions, snags, overhanging trees, etc., the excavation of a channel by blasting through rock reefs, dredging sand bars, and the building of spur dams of brush and riprap to confine the water in the improved channel to obtain a low-water depth of from 2½ feet to 3 feet.

The expenditure to May 7, 1896, has been $116,796.67.

As a result, the lower 13 miles of the White River are navigable for boats drawing 3 feet all the year; above this to the junction and about five miles up East Fork, boats drawing 18 inches can navigate for about six months of the year.

Low-water navigation on the forks is impracticable even for the smallest boats.

The present survey has been made to cover the White River proper and those parts of the forks which, after the examination of 1878, were regarded as susceptible of improvement without the use of locks and dams, viz, White River from its mouth to the junction of the two forks, 48 miles; East Fork from its junction with the West Fork to Portersville, 20¾ miles; West Fork from its junction with East Fork to the Baltimore and Ohio Southwestern Railway Company's bridge, 14 miles; in all, 82¾ miles.

That portion of the river under consideration is naturally divided into three parts, as indicated above, viz:

White River.—The main stem of the stream from the junction of the forks to the mouth has an average width of 400 feet; a depth at low water varying from 2 feet to 10 feet; the fall per mile is 0.566 foot. The banks are fairly high, 8 feet to 29 feet above low water; they are usually caving and unstable in all places where the cultivated land extends to the river. Those portions covered with trees, while not so unstable, are a constant source of snags.

As stated above, the lower 13 miles have a navigable channel 3 feet in depth all the year. Above this are several obstructions in the form of rock reefs, sand bars, and snags; these can, I think, all be so improved by open-channel works as to carry the 3-foot channel to Blackburn Station, 46 miles above the mouth of the river, at an estimated cost of $112,859.

East Fork.—This section has an average width of 250 feet, a low-water depth, varying from 1 foot to 9 feet, and the fall per mile is 0.6433 foot. The banks are fairly high, 8 feet to 24 feet above low water, with the same characteristics as to stability, etc., as are mentioned concerning the first section.

The obstructions here, while of the same nature as those in the main stream, are more numerous, and with the low-water slope, as stated, the measured discharge would not furnish water sufficient for a 3-foot low-water channel. For this reason the channel depth has been limited to 2 feet, which can, I think, be obtained by the method of open-channel improvement at an estimated cost of $107,118.

West Fork.—This section has an average width of 180 feet; a depth at low water varying from 0.5 foot to 5 feet, and the fall per mile is 1.1836 feet. The banks vary in height from 8 feet to 25 feet above low water; are very unstable at many places where the forest growth has been removed, and affords a prolific source of snags in those portions covered with trees.

The obstructions in this section are of the same general character as those in the other two sections, but by reason of its greater slope and very small low-water discharge—350 cubic feet per second—the improvement of this fork can only be effected by the use of locks and dams, three of which, with lifts of about 7 feet, would be required to give a low-water depth of 2 feet to the "Falls," at an estimated cost of $330,000.

Should such improvements be inaugurated further examination would be required for the location of the locks and dams. But it may be stated that by the location of one of them at or near Rocky Ford Ripple, 42½ miles from the mouth of White River, certain of the regulation works for the East Fork would be rendered superfluous and the estimate diminished correspondingly, making the total estimated cost of the improvement $465,946. In addition to this, the caving of the unstable banks would render necessary an annual expenditure for snagging and dredging of at least $6,000, or an expensive system of bank protection.

These figures, taken in connection with correspondence (appended) with many prominent citizens of the locality, indicate that the cost of the improvement is far in excess of what would be justified by the present demands of commerce; the future demands will, in my opinion, be dependent upon the commercial effect of the prospective improvement of the Wabash River. At present that stream affords no outlet for the produce of the White River, excepting at high stages of water, and has no commerce of its own. The navigation of this stream, as on the White River, is only by a few small light-draft steamers and barges, which at favorable seasons take grain and produce from the farms adjacent to the river banks for delivery to the nearest railroad.

In view of the above, it is respectfully submitted that the improvement of White River, Indiana, should be suspended until the navigation of the Wabash has been so improved as to afford an outlet for any traffic which may then be developed on White River.

The maps* to accompany this report, now under preparation and well advanced, will be forwarded as soon as completed.

Very respectfully, your obedient servant,

J. G. WARREN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

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* Not printed.

[First indorsement.]

U. S. ENGINEER OFFICE,
NORTHWEST DIVISION,
New York, June 5, 1896.

Respectfully forwarded to the Chief of Engineers, U. S. Army.

I concur in the opinion of Captain Warren that there is nothing now to justify the large expenditure necessary to improve the White River, as its use would be prevented by the condition of Wabash River, and that the further improvement of the White River should be postponed until the improvement of the Wabash has been so improved as to afford an outlet for any traffic which may then be developed on White River.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. THOMAS P. SHANKS, ASSISTANT ENGINEER.

LOUISVILLE, KY., *May 8, 1896.*

CAPTAIN: I have the honor to submit the following report on the survey of White River, Indiana, and portions of the East and West forks thereof:

The purposes of the survey included the collection of all data necessary to prepare maps of the main stem of the river, the East Fork to Portersville, Ind., and the West Fork to a point known as "The Falls," near Washington, Ind.; the collection of all data relating to the present condition of these streams, in order to determine the practicability and cost of providing a navigable channel suitable for the present and prospective demands of the commercial interests of the localities through which the streams flow.

The East Fork rises in Bartholomew County, Ind. It flows southwest through Jackson County to its south line; thence west, forming the boundary between portions of Jackson and Washington counties; west through Lawrence County, passing near the city of Bedford; southwest through Martin County to its south line; thence west, between the counties of Martin and Daviess on the north, and Dubois and Pike on the south, to its junction with the West Fork, a distance of about 140 miles.

The portion under consideration extends from the junction up to Portersville, which is in Dubois County on the south side, 2 miles below, and on the opposite side from the dividing line between Martin and Daviess counties.

The West Fork rises in Randolph County, in the northeastern part of Indiana, and flows westwardly through the city of Muncie, in Delaware County, and Anderson, in Madison County; thence southwestwardly through Hamilton County, through Indianapolis, in Marion County, and the northwest corner of Johnson County, centrally through Morgan County, and thence as a dividing line between portions of Owen and Monroe counties, through Owen and Green, where it then becomes the boundary between Knox and Daviess counties, flowing south from Edwardsport to the junction with the East Fork, a distance of about 220 miles.

The portion of this stream under consideration extends from the junction of the two forks up to the crossing of the Baltimore and Ohio Southwestern Railroad, near the city of Washington, in Daviess County.

The two forks form the main stream of White River, which flows south of west, with Knox County on the north, and Pike and Gibson counties on the south, to its junction with the Wabash River opposite Mount Carmel, Ill., which is about 90 miles by river channel from the point where the Wabash empties into the Ohio River.

The West Fork, although about 80 miles longer, is much the smaller stream. The East Fork has many large tributaries, among which are Lost River, Indian Creek, Muscatatuck, North Fork, and Salt Creek, which make the discharge nearly double that of the West Fork.

The party, consisting of 14 men in all, with Mr. William B. Tabb as transitman, Mr. Oscar Shanks, draftsman, and myself as leveler in local charge, went into camp the 29th of October, 1895, on the West Fork of White River, near the pumping station of the Washington waterworks, which is 4 miles below the crossing of the Baltimore and Ohio Southwestern Railroad. This bridge was made the initial point and the survey proceeded down the West Fork to the junction, a distance of 14.4 miles, and thence down White River, a distance of 4.2 miles, to Starks Ferry. From the junction up the East Fork to Portersville, a distance of 21.87 miles, and then from Starks Ferry down the main stream to its junction with the Wabash River, 45.31

miles; total length of the angle lines, 85.78 miles. Field work closed January 17, 1896.

The survey consisted of an examination with the transit and stadia and a line of levels to determine the fall of the river. The elevation of the water surface was taken at every transit station, and bench marks established at all well-known points, generally about 1 mile apart. The maps made from notes taken will show the location of the streams with all their meanders, sand bars, shoals, ripples, etc., the character of the banks, cultivated lands, timber lands, etc. Soundings were taken across the stream at 400-foot intervals, except where shoals and rock ripples required closer examinations. The character of the bottom of the river was carefully examined with sounding rods and elevations taken for cross-sections at all points thought to be necessary.

A gauge was placed in White River about three-quarters of a mile above the mouth. Zero on this was fixed at the same relative height as the zero of the gauge on the Wabash below the dam at Grand Rapids, which is 0.35 of a foot below the extreme low water of 1895. Another gauge was placed at Petersburg Landing, the zero point of which was fixed at 1 foot below low water. Temporary gauges were also used at the different camps, but the freshets and fluctuations of the river and the distances of these gauges from the leveling party while at work have necessarily caused some uncertainty as to the precise elevation of low water on some of the reaches of the survey. The approximations made are believed to be as close as possible under the conditions. The low-water slope has been calculated for all the transit stations in order that the discharge of a proposed improved channel may be readily determined at any point.

The upper 4 miles of the main stream, the lower 4 miles of the East Fork, and all of the West Fork were surveyed during low water, and the discharge of the West Fork was measured during that stage. On the other portions of the streams the gauges showed a rise of from 2.5 to 2.7 feet above low water at the time of measuring the discharges. The highest rise during the survey was 7.4 feet at Petersburg gauge, December 30, 1895.

The plane of reference used is the sea level, taken from the Government bench mark placed on the sill of the southeast window of the basement of the Daviess County court-house, at Washington, Ind., by the United States Engineer Corps during the geodetic survey along or near the thirty-ninth parallel from Sandy Hook to St. Louis, Mo., in 1882, the elevation of which, as recorded by Mr. Smiley, the city engineer of Washington, Ind., is 155.5829 meters above zero at Sandy Hook.

The two forks of White River, as well as the main stream to its junction with the Wabash River, flow through broad valleys of highly fertile and well-cultivated lands, the soil consisting generally of an upper stratum of rich, light loam, overlying sand and gravel. The banks are usually very unstable, the streams are winding, and in places there are great loops and horseshoe-shaped bends many miles in length, in some of which there are threatening probabilities of high-water cut-offs which would connect the bases of the loops by new channels of from one-tenth to one-third of the distance around them. Two notable cases of changes of channel have recently occurred, one on the West Fork near Washington, where the new bed of the river has cut off more than 200 acres, and the greater part of the old channel is now cultivated land; the other on the East Fork, where a partially filled well is all that now remains to mark the site of what was once the prosperous village of London. The well was formerly some distance from the river, with stores, sawmill, blacksmith shop, etc., between it and the bank; now they are all gone and the well itself is very near the edge of the encroaching stream.

In many places remarkable evidences of the location of former channels are found in the curved alignment of very large, old, and decaying sycamores growing far back, sometimes more than a mile from the present banks.

A longitudinal profile of some of the high sand bars presents a very gradual ascent from the upper end, rising occasionally as high as the level of the adjoining bank and breaking off abruptly at the lower end in a series of terraces, with slopes from one to the other as steep as the nature of the material will permit, showing by these deposits the changes of the current at different stages of high water. Several points were noticed where the locality of the old low-water line was shown by large willows, some of which were 2 feet in diameter, growing at an angle of from 30 to 40 degrees with the water, but the roots of which were buried far below the surface of the high sand bar.

In August, 1875, occurred an extraordinary high water; well authenticated marks at different points along the river show it to have been on the average more than 29 feet above the very low water of 1895.

Snags are so very numerous at several places that even the passage of skiffs is attended with great difficulty. The larger snags are generally in the deep water, the bars are usually free, but the sand shoals have many logs partly buried which can not be seen until the skiff is almost upon them. A reach of 2,000 feet on the

West Fork would cost probably $300 to clear the channel. A photograph taken of this reach, but which was spoiled in the development, would have shown a sample of only such snags as appear above water. Probably ten times as many more are partly imbedded in the sand, entirely submerged by the water, and would not have appeared in the picture at all.

The great number of snags in the West Fork ought, perhaps, to make the "coefficient of roughness" in Kutter's formula more than 0.030 as used in the calculations not only for the purposes of this report, but generally in computing the flow of water in channels of this character.

Eight miles below the Baltimore and Ohio Southwestern Bridge on the West Fork is a long shallow sand shoal, the banks of which are fairly good, but the loose sand in the bottom of the river appears to be constantly moving downstream. A contour line of 6 inches depth of water could be located, showing a diagonal connection between the foot of one flat bar and the head of another lower down on the opposite side of the stream. The low water is about 200 feet wide and very shallow; the slopes on this shoal vary from 0.000266 to 0.000578; the steepest one will discharge 367 cubic feet, and the flattest only 248 cubic feet per second, through a channel 100 feet wide, 350 cubic feet per second being the observed discharge at low water.

The movement of the sandy sediment changes the shoals from one place to be deposited in another, sometimes rendering a dike useless at the place where it was built and necessitating the construction of another at the new shoal. The movements, however, do not occur at all the shoals and bars, and they are sometimes very slow, as shown by comparing the surveys made by Mr. Petitdidier in 1878 and 1879–80. Many bars and shoals shown on the earlier survey are now just as they were then, but in other instances the transformation has been very remarkable.

For the purpose of estimating the low-water discharges of the East Fork and White River the normal profile was taken from the cross sections of those streams after the observed surface had been reduced to the estimated low-water stage. From this normal profile the area and hydraulic radius were obtained and the same slope was used for low water as that observed on the high stage. Both streams were slowly rising at the time of making the observations.

Under such conditions some uncertainty must necessarily exist, but it is believed that the estimated low-water discharges for these two streams, as stated in the table below, are close approximations.

Description of data.	West Fork.	East Fork.	White River.
Distance on angle line in miles	14.40	21.87	49.51
Distance on line of channel in miles	14	20.75	48
Fall in feet for entire length of survey	16.57	13.35	27.17
Fall per mile at low water in feet	1.1836	0.6433	0.566
Total fall divided by the entire length of the channel $\frac{h}{l}$="S"	0002242	0001219	0001072
Low-water discharge in cubic feet per second	350	570	1,475

The bench marks established on this survey were formed, except where otherwise described, by cutting a notch in the projecting root of a tree, generally about 1 foot above the ground, with the upper part trimmed up the tree to allow space and surface for marking, and the lower face of the notch horizontal; this level part was then cut so as to form a vertical projection about 1 inch high, like a frustrum of a pyramid, with the top about 1 inch square, into which a 4-inch wire nail was driven to the head. They are numbered and located as follows:

ON THE WEST FORK.

No. 1. Top of coping stone, east end of Baltimore and Ohio Southwestern Railroad Bridge across the West Fork of White River. Elevation, 452.72.

No. 2. On stone sill of entrance to engine room of the pump house of the Washington water works. Elevation, 438.70.

No. 3. Ash tree, 1 foot in diameter, on left bank near the corn cribs on Hiram Hyatt's land, 200 feet below station 252+83. Elevation, 434.05.

No. 4. Sugar maple, 2 feet in diameter, 250 from shore on left bank in west line of Sec. 18, T. 2 N., R. 7 W. Elevation, 433.22.

No. 5. Oak, 3 feet in diameter, right bank, property line dividing woodland from cleared land. Elevation, 430.22.

No. 6. Hackberry, 2½ feet in diameter, right bank, near fence line between wooded land and cornfields. Elevation, 430.58.

No. 7. Large twin sycamores, right bank, at McCoys Ferry. Elevation, 428.92.

EAST FORK.

No. 8. Elm, 4 feet in diameter, right bank, quarter of a mile above the junction at Kenderhook Ferry. Elevation, 420.02.

No. 9. Plinth of north pier of Evansville and Indianapolis Railroad Bridge. Elevation, 406.13.

No. 10. Large double sycamore, one of which leans out horizontally over the water near corncribs, right bank. Elevation, 423.

No. 11. Three sycamores growing together, right bank, at mouth of creek. Elevation, 426.87.

No. 12. Thorn tree 3 feet in diameter, right bank, old site of the village of London, McCracken's property, tree near residence on east line of section 10. Elevation, 434.51.

No. 13. Walnut stump at root of double walnut, 6 inches in diameter, right bank, isolated. Stump was used as hub for station 1069+60. Elevation, 431.92.

No. 14. Double sycamore at High Banks Ferry, left bank. Elevation, 428.16.

No. 15. Double honey locust, right bank, 500 feet above point opposite mouth of Bush Creek. Elevation, 433.67.

No. 16. Soft maple grown double, right bank, opposite station 1241+29. Elevation, 425.44 feet.

No. 17. Sugar maple in yard of residence on right bank at Harrimans Ferry. Elevation, 436.66.

No. 18. Soft maple, 3 feet in diameter, right bank 250 feet above mouth of small creek, tree leans toward the river 45 degrees. Elevation, 429.87.

No. 19. Small cottonwood, 6 inches in diameter, one of five growing close together, right bank, opposite mouth of creek. Elevation, 425.88.

No. 20. Pecan tree, 4 feet in diameter, isolated in open field, above mouth of creek, which is 100 feet above Armes Ferry. Elevation, 429.57.

No. 21. Large double sycamore, right bank, at Hemsleys Ferry Landing. Elevation, 435.93.

No. 22. Elm, 2½ feet in diameter, right bank, 60 feet from Hemsley's barn. Elevation, 434.03.

No. 23. Red sycamore, 2½ feet in diameter, right bank, in front of Pret Allen's house, below iron bridge over creek. Elevation, 436.58.

No. 24. Sycamore, 4 feet in diameter, left bank, opposite High Rock; station, 1769+15. Elevation, 439.28.

No. 25. Leaning sugar maple, left bank, opposite the mouth of Sugar Creek. Elevation, 442.98.

No. 26. Elm, 4 feet in diameter, left bank, above ferry landing at Portersville. Elevation, 437.32.

ON WHITE RIVER.

No. 27. Cottonwood, left bank, used as mast for wire trolley line at Starks Ferry. Elevation, 415.95.

No. 28. Basswood, 3½ feet in diameter, left bank, 400 feet below mouth of Prides Creek. Elevation, 424.59.

No. 29. Sycamore, 3 feet in diameter, left bank, in front of Fulsche residence. Elevation, 421.65.

No. 30. Beech, 2½ feet in diameter, left bank, near district schoolhouse. Elevation, 424.89.

No. 31. Elm, 3 feet in diameter, one of three large trees growing close together, left bank, at the point where the county road strikes the river. Elevation, 416.81.

No. 32. Oak, 2½ feet in diameter, isolated, left bank, point of curve in Seven-Mile Bend. Elevation, 419.03.

No. 33. Solitary sugar maple, left bank, in field 900 feet above island. Elevation, 418.62.

No. 34. Sycamore, 5½ feet in diameter, right bank, at the residence of Thomas Stone on the Johnson farm. Elevation, 416.67.

No. 35. Honey locust, 2 feet in diameter, left bank, at Fredericks Landing. Elevation, 416.16.

No. 36. Leaning, forked, soft maple, 2½ feet in diameter, right bank, opposite mouth of creek. Elevation, 411.15.

No. 37. Sycamore, 2 feet in diameter, left bank, mouth of ravine at Buena Vista. Elevation, 415.12.

No. 38. Elm, 2½ feet in diameter, left bank, 500 feet below creek. Elevation, 410.52.

No. 39. Monument stone, left bank, dividing property lines, 500 feet below station 2071+92. Elevation, 407.79.

No. 40. Sycamore sapling, left bank, growing below the top of the bank, station 2152+90. Elevation, 407.68.

No. 41. Coping of pivot pier of Evansville and Terre Haûte Railroad Bridge. Elevation, 416.47.

No. 42. Locust, 1 foot diameter, right bank, at Creek Bridge. Elevation, 409.64.

No. 43. Sugar tree, 1½ feet diameter, right bank, at point of bend opposite Hazleton, 1,200 feet above upper ferry. Elevation, 410.27.

No. 44. Oak, 1½ feet diameter, right bank, at James Tucker's house. Elevation, 409.06.

No. 45. Walnut, 2½ feet diameter, right bank, lower point of ravine crossed by iron bridge. Elevation, 407.58.

No. 46. Beech, 2 feet diameter, right bank, at Edw. Bell's residence. Elevation, 409.01.

No. 47. Large cottonwood, right bank, in front of Decker's residence at mouth of lane. Elevation, 395.23.

No. 48. Sugar maple, 2½ feet diameter, right bank, at mouth of lane. Elevation, 404.08.

No. 49. Soft maple, 2 feet diameter, right bank, 600 feet below a point opposite mouth of creek. Elevation, 401.25.

No. 50. Oak, 6 feet diameter, right bank, at Cunninghams Ferry. Elevation, 403.44.

No. 51. Elm, 2 feet diameter, right bank, 300 feet above Alex. Ravellette's residence. Elevation, 395.96.

No. 52. Leaning sycamore, 3 feet diameter, left bank, at Bingham's barn. Elevation, 395.30.

No. 53. Hackberry, 2½ feet diameter, left bank, at upper end of guiding dike of Kellys Ripple. Elevation, 393.93.

No. 54. Oak, 3 feet diameter, left bank, in edge of woods 300 feet below the cultivated land. Elevation, 400.78.

No. 55. Oak, 3 feet diameter, left bank, 200 feet below residence on the "Ki" Clark farm. Elevation, 401.22.

No. 56. Sill of front door of schoolhouse No. 12, left bank. Elevation, 400.78.

No. 57. Solitary tree, right bank, on upper point at mouth of White River. Elevation, 395.68.

No. 58. Coping of lock wall at Grand Rapids Dam on Wabash River. Elevation, 398.42.

HIGH-WATER MARKS.

[Showing the height of the freshet of August, 1875.]

West Fork.

Auger hole in tree on the road leading from Washington to the water-works pumping station, one-quarter of a mile from the river:

	Feet.
Elevation	443.65
Low water	417.29
Difference	26.36

East Fork.

Foot of fence post near High Banks Ferry, left bank, pointed out by Mr. Dan Mershon:

	Feet.
Elevation	438.99
Low water	408.38
Difference	30.61

Nail in sycamore, left bank, just above ferry landing in Portersville, marked by Mr. John A. Krodel and witnessed by Mr. M. W. Harris, both of Portersville.

	Feet.
Elevation	446.47
Low water	416.58
Difference	29.89

White River.

Nail in sycamore, left bank, east side of Prides Creek at bridge approach, vouched for by G. W. Query and James Willis:

	Feet.
Elevation	430.55
Low water	402.05
Difference	28.50

Window sash and mark on mantel in Jos. Willis's house, left bank, near Rock Ripple:

	Feet.
Elevation	430.72
Low water	401.90
Difference	28.82

Mark on door frame of Odd Fellows Hall, in Buena Vista, pointed out by several citizens of that place:

	Feet.
Elevation	422.02
Low water	390.28
Difference	31.74

The bridges crossing the stream within the limits of this survey are described as follows:

The Baltimore and Ohio Southwestern Railroad, across the West Fork, near Washington, Ind.: Masonry piers and iron superstructure; not provided with draw; two spans 200 feet each; elevation of base of rail 452.72.

	Feet.
Lowest part of superstructure	448.59
Low water	419.75
Vertical clearance	28.84

The Evansville and Indianapolis Railroad, across the East Fork at Rodgers Station, above the junction: Five spans, one of 100 feet, three of 90 feet each, and a channel span of 160 feet horizontal clearance at low water; masonry piers; iron superstructure; not provided with draw; elevation of base of rail 443.88.

	Feet.
Lowest part of superstructure	439.46
Low water	403.98
Vertical clearance	35.48

The Evansville and Terre Haute Railroad, across White River at Deckers Station, above Hazleton: Masonry piers; iron superstructure; three spans, 125, 172, and 140 feet, and one draw span of 180 feet, with 75 feet horizontal clearance for channel on west side of pivot pier; elevation of base of rail 423.69.

	Feet.
Lowest part of superstructure, draw span	419.92
Low water	394.41
Vertical clearance without opening draw	25.51

White River from its mouth to the junction of the two forks, and about 5 miles above, on the East Fork, is navigable at the higher stages of water, during a period of probably five or six months of the year, for boats drawing from 18 inches to 2 feet of water; several small steamboats 60 to 70 feet in length by 12 to 20 feet beam make occasional trips during the winter months for the purpose of bringing barges loaded with wheat, corn, and other agricultural products to the railroads which cross the streams.

Navigation with the smallest barges, even if they were lightened to an 8-inch draft and with the channel cleared of snags, is wholly impossible on both forks at low water.

The recent improvement at Kellys Ripple, about 3 miles above the mouth of White River, described in another part of this report, has made that stream navigable all the year, from its mouth to the foot of a sand shoal about 13 miles above, for boats drawing 3 feet of water; but communication with the lower Wabash at low water is prevented by a rock reef about half a mile below the junction of the two streams.

When that portion of the Wabash River between the mouth of White River and the Ohio, about 90 miles in length, shall have been improved, White River will form a considerable tributary to the through or trunk route to the Ohio River.

The entire counties of Martin, Daviess, and Pike, with part of Dubois and Gibson, and more than half of Knox County, will be greatly benefited by the improvement of these streams. They will have an outlet for their agricultural products, and an inducement for developing extensive coal mines and rock quarries.

The deepening of the channel in solid rock is regarded as a permanent improvement, requiring little or no attention, while the unstable character of the banks and bottom in the vicinity of many of the proposed channel contractions will render it necessary to give some care and attention from time to time to the brush dams and crib dikes which will have to be built.

It is difficult to form a very close estimate of the cost of repairs and renewals of these temporary structures, because the narrowing of the channel increases the depth and velocity of the water; the consequent scouring of the bottom changes the slope and makes all the conditions different from what they were before the improvement was made. The location and length of all the dikes can not therefore be well determined in advance of construction. It is respectfully recommended that some of them be built and their effect observed before locating others for regulating the same shoal. It is believed, however, that the estimates of cost will be sufficient to cover the outlay for improving the channel through all the difficult places.

As a result of these examinations and a careful study of the data obtained, as well as the present and prospective demands of commerce, the following conclusions and estimates are submitted:

First. An adequate width of 100 feet, with a depth of 3 feet at low water, can be obtained by an improved open channel from the mouth of White River to Blackburn Station, above Petersburg Landing, a distance of 46 miles.

Second. An adequate width of 100 feet, with a depth of 2 feet at low water, can be obtained by an improved open channel from Blackburn Station to Portersville on the East Fork, a distance of 22¼ miles.

Third. The small low-water discharge of about 350 cubic feet per second renders the improvement of the West Fork impracticable by any method other than slack water.

Therefore, in estimating the cost of improvement, the limits of the survey may be naturally divided into three sections embracing the reaches of river just mentioned, with an alternative estimate for improvement of the first and second sections.

FIRST SECTION.

In a project for the improvement of the river by the method suggested, Blackburn Station, nearly 2¼ miles below the junction of the two forks and 2¼ miles above Petersburg Landing, would be the most practicable and useful terminus for the 3-foot low-water open channel. The reasons upon which this conclusion is based are as follows:

Blackburn is near the head of a long pool in which there is a depth of more than 9 feet at low water; this pool is used as a harbor during the low-water season for the steamboats *Belmont*, *Hugh Barr*, and their barges; it is also one of the best ice harbors on the river. Blackburn is an important shipping port. The Evansville and Indianapolis Railroad touches the river at this point at an elevation of 43 feet above low water; a permanent spur track down the side of the railroad embankment connects with an elevator and a sawmill, both of which are on the level of the natural bank of the river 23 feet above low water. By means of this connection grain may be transferred and lumber, which is cut from logs taken out of the river, may be shipped by rail.

Hazleton, another important river town, is also included in this section. Besides great business interests in handling and shipping grain, Hazleton has large mills and railroad connection.

The river now has a navigable channel of 3 feet from the mouth to a point 13 miles above, and the same depth should be extended to Blackburn, in order to accommodate the larger boats from the Wabash River.

The only permanent improvement on this section is at Kellys Ripple, about 3 miles above the mouth of the river. A chute has been excavated through the rock reef, which is 2,000 feet long and 100 feet wide, with a depth of 8 feet from the top of the guiding dikes to the bottom of the cut. Wing dams extend to the shore from each side of the upper entrance for the purpose of confining the water to the narrowed channel. The fall in the entire length, as shown on the plans by which the improvement was made, is 1.75 feet; applying Kutter's formula, as used by Mr. P. J. Flynn in his "Flow of Water in Open Channels," to this data, it is found that with .030 as a "coefficient of roughness," 4 feet in depth will discharge 1,420 cubic feet per second. The estimated discharge at low water from observations taken 1 mile below the ripple is 1,475 cubic feet per second, but the observed fall on Kellys Ripple was only 1.36 feet at a stage of 3.32 feet above low water. A navigable depth of 3 feet may, therefore, be safely reckoned for the entire year. The wing dams and places in the guiding dikes are partly broken, allowing much of the water to find its way outside of the excavated channel.

An attempt, made some years ago, to protect the bank at Thorns Eddy, about three-quarters of a mile above the Evansville and Terre Haute Railroad Bridge, has proven a failure. The piling which was driven along the bank near what was then the edge of the water is now about the center of the channel. These timbers project about 5 feet above low water and form a considerable obstruction. No other evidences of improvement on this section were observed except the work of the snag boat.

ESTIMATE OF COST.

Beginning at the mouth of White River, the first improvement should be the repairs to the dikes of Kellys Ripple about—

3 miles from the mouth, costing about		$1,000
13 miles is a narrow channel to be widened by the dredge, one week's time		250
14 miles, sand shoals 1,300 feet long, requiring 800 feet spur dikes, at $2.		1,600
15 miles, about 1,400 feet of rock, averaging 1.15 feet cut, 100 feet wide, about 6,000 cubic yards excavation, at $3	$18,000	
Building and placing 6,222 cubic yards loose rock, at 50 cents	3,111	
500 feet shore dikes, at $1.30	650	
		21,761
Snag boat, $500; dredge 1 month, $1,000		1,500
		26,111
Engineering expenses and contingences		5,222
Total for 3-foot open channel all the year from mouth of White River to Hazleton, 18 miles		31,333

Between Hazleton and Deckers, which is—

22 miles, there are sand shoals requiring 8 spur dikes of about 125 feet each, at $2.50		2,500
33 miles, 400 feet sand shoals to be dredged, and 1,400 feet shoal to be diked; 900 feet, at $3		2,700
34 miles, 700 feet sand shoal; 400 feet dikes, at $3		1,200
35 miles, 2,800 feet sand shoal; 1,680 feet dikes, at $3		5,040
38 miles, two short shoals; 480 feet dikes, at $3		1,440
39 to 41 miles, above and below Williams Ferry; 7,350 feet dikes, at $2.50.		18,375
42½ miles, Rocky Ford Ripple, below Petersburg Landing, 1,400 feet long, 100 feet wide, and 1.54 feet deep; about 8,000 cubic yards rock excavation, at $3	$24,000	
Guide dikes, 2,800 by 15 by 3 feet=4,667 cubic yards, at 50 cents.	2,333	
Shore dikes, 500 feet, at $1.30	650	
		26,983
44 miles, sand shoals 1,200 feet long; 720 feet dikes, at $2.50		1,800
45 miles, sand shoals 1,800 feet long; 1,360 feet dikes, at $2.50		3,400
Snag boat, 2 months, $750		1,500
Dredge boat and barges, 3 months, $1,000		3,000
Engineering expenses and contingencies		13,588
Total for 3-foot open channel all the year from Hazleton to Blackburn.		81,526
Add the estimated cost for same below Hazleton		31,333
Total for 3-foot open channel, all the year, from the mouth of White River to Blackburn, 46 miles by channel		112,859

SECOND SECTION.

East Fork.

Above Blackburn there are no wharves, elevators, or other facilities for the transfer of freight. While it is possible to get to Portersville, on the East Fork, 68¾ miles from the mouth of White River, with a 3-foot open channel during the entire year, it is not believed that the cost of such a channel would bear a fair relation to the advantages obtained therefrom. nor do the present or prospective demands of the commercial interests of this section of country seem to require a greater low-water channel depth than 2 feet. In accordance with this conclusion it is recommended that this depth be adopted for low water in estimating the cost of improving the reach from Blackburn to Portersville.

Several years ago the snag boat operated as far up as half a mile above the junction. Leaning trees projecting over the channel, which is very close up against the left bank at this point, have been cut away. With the exception of the snag boat's work no other evidences of improvement of the channel were noticed on this section.

ESTIMATE OF COST.

From the mouth of White River to Blackburn is 46 miles, and from this point to the junction is a reach of nearly 2¼ miles, in which there are several large bowlders and loose rocks which should be removed and some narrow places in the channel to be dredged; all of which may be done by such boats.

Going up the East Fork, the first obstruction is at the railroad bridge, and just above that point about—

49 miles from the mouth of White River, clearing a large raft of drift from around the piers of the railroad bridge, dredging and building dikes for 3,300 feet of sand shoal, 2,000 feet dikes, at $2.50		$5,000
51 miles; 4,000 feet sand shoal, 2,400 feet dikes, at $2.50		6,000
52 miles; 1,800 feet sand shoal, 1,100 feet dikes, at $2.50		2,750
52¼ miles; Rock Ripple and Rock Bar on left side, excavation 1,500 by 100 feet by 0.9 foot=5,000 cubic yards, at $3	$15,000	
1 shore dike, 200 feet, at $1.30	260	
Building and placing loose rock, 2,000 by 15 by 4 feet=about 4,500 cubic yards, at 50 cents	2,250	
		17,510
55 miles; High Banks, 2,300 feet sand shoal, 1,600 feet dikes, at $2.50		4,000
58 miles; rock reef, 400 feet long, 1,500 cubic yards excavation, at $3		4,500
59 miles; 3,000 feet sand shoal, 2,100 feet dikes, at $2.50		5,250
60 miles; 900 feet sand shoal, 700 feet dikes, at $2.50		1,750
65 miles; shale reef at Flat Rock Ferry; 5,000 cubic yards excavation, at $2 per cubic yard	$10,000	
Dikes and wing dams	2,650	
		12,650
66 miles; removing old milldam at High Rock and excavating channel; 4,000 cubic yards rock excavation, at $3	12,000	
500 feet dikes, at $1.30	650	
Building and placing rock in guiding dikes, 2,200 by 15 by 4 feet=about 5,000 cubic yards, at 50 cents	2,500	
		15,150
67 miles; rock shoal, 400 by 100 feet by 0.8 foot=1,185 cubic yards, at $3	3,555	
Guiding dikes, building and placing 4,000 cubic yards, at 50 cents	2,000	
Shore dikes, 500 feet, at $1.30	650	
		6,205
68 miles; sand shoals, 3,500 feet long; 2,000 feet dikes, at $2.50		5,000
Snag boat, 2 months, $750		1,500
Dredge boat, 2 months, $1,000		2,000
		89,265
Engineering expenses and contingencies		17,853
Total from Blackburn by open channel all the year with 2 feet of water to Portersville, 22¼ miles		107,118

THIRD SECTION.

West Fork.

In the West Fork, as has been stated, there is not water enough to fill an open channel 100 feet wide and 2 feet in depth; its improvement is therefore not recommended, because navigation can only be obtained by means of slack water; and the great cost of locks and dams would not bear anything like a fair relation to the commercial advantages obtained.

If it is desirable to consider the extension of navigation up this stream by slack water, a rearrangement of the foregoing estimates may be necessary.

The construction of a lock and dam with a lift of 7 feet at Rocky Ford Ripple on White River below the Petersburg Landing, which is an excellent location, would produce slack water up the East Fork to a point near the village of High Banks, which is 7 miles above the junction; but the same pool would extend only 3 miles up the West Fork. There would then be required two more locks and dams to make that stream navigable to a point above Washington.

These locks are estimated for a length of 150 feet between miter sills, 30 feet in width, a lift of 7 feet, with 4 feet of water on the sills and a head wall height of 10 feet above the crest of the dam, with gates and valves to be operated by hand power. The coping, sills, and exposed faces of the walls are calculated for cut stone; all other parts of the walls for concrete.

The dams are estimated for a length of 700 feet and of the same form of stone-ballasted crib dam as that now in use at Grand Rapids, on the Wabash River.

Without making a special survey and location, the cost of one lock and dam is estimated as follows:

For the lock:		
2,000 cubic yards earth excavation, at 25 cents	$500	
2,000 cubic yards rock excavation, at $1	2,000	
4,000 cubic yards masonry, averaging $8	32,000	
Gates, valves, etc	7,000	
		$41,500
For the dam:		
700 feet long; cribs filled with stone, 6-inch oak sheeting embankment behind it; detailed estimate makes an average of $46.60 per foot		32,620
One abutment:		
800 cubic yards earth excavation, at 25 cents	$200	
580 cubic yards masonry, at $8	4,640	
		4,840
Levee and bank protection		8,000
Land, 10 acres, at $100		1,000
Houses and fencing		2,500
Depreciation of tools		1,000
		91,460
Engineering expenses and contingencies		18,540
Total cost of lock and dam		110,000

In considering these improvements it is suggested that if a lock and dam is built at Rocky Ford Ripple below Petersburg Landing, the estimated cost of which is $110,000, and this amount credited by the total estimated work on open channel rendered unnecessary thereby, $84,031, it would make a difference of only $25,969, and that this work might be used to great advantage for possible future necessities which are not now apparent.

SUMMARIES.

Estimate for 3-foot open channel to Blackburn	$112,859
Estimate for 2-foot open channel, Blackburn to Portersville	107,118
Total for an adequate open channel between mouth of White River and Portersville	219,977

If lock and dam is built at Rocky Ford Ripple, the cost of the first and second sections would be—

For open channel on White River, below the proposed lock site	$67,740
Lock and dam	110,000
Open channel on East Fork above slack water	68,206
Total	245,946

For entire length of river within the limits of this survey—

Open channel below Rocky Ford Ripple	$67,740
Open channel, East Fork, above slack water	68,206
Three locks and dams, at $110,000 each	330,000
Total	465,946

Respectfully submitted.

Thos. P. Shanks, *Assistant Engineer.*

Capt. J. G. Warren,
Corps of Engineers, U. S. A.

LETTER OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Louisville, Ky., January 24, 1896.

SIR: I am engaged in preparing a report upon a survey of White River, Indiana, and desire to include in the report statistics of all commodities that are produced and shipped from, or brought into, the section through which the river flows. To enable me to make the report as full and complete as possible, I have to request you to kindly give me any data you may have at hand, in answer to the following inquiries:

What quantity of each commodity has been shipped during the past year? Was the shipment made by railroad or steamboat? From what points were the shipments made, and to what points?

If possible, state separately the shipments by rail and steamer, together with the estimated value of the shipments.

What are the principal articles produced by and shipped from the White River Valley?

Would the production of these articles be increased or any advantage be gained if the stream were made navigable at all seasons?

Are there any coal veins, stone quarries, or other interests along the river that the improvement of the river would cause to be developed?

What rates are charged by the railroad companies for carrying the products you mention to the markets, and would those rates be affected in anyway by river competition?

Supposing that no outlet by water was available for boats plying in the White River trade and the commodities would have to be reshipped by rail, would the improvement of the river, as an isolated waterway, be beneficial?

Have you any commercial statistics of the river during previous years? If so, what are they?

* * * * * * *

I shall be glad to receive all the information on the subjects mentioned that you may be able to furnish, and would also deem it a favor if you furnish me the names and addresses of others who you think can furnish data additional to that furnished by you; or, if it be no inconvenience to you, will you kindly request them to send such information direct to me? If it be possible to obtain it, it is desired to have the report comprise everything available concerning the traffic and commerce of the section under consideration, therefore each and every commodity should be included, in order that the tabulated statistical data may be as nearly correct as possible.

Very respectfully,

J. G. WARREN,
Captain, Corps of Engineers.

LETTER OF MR. FRANK W. HAVILL.

MOUNT CARMEL REGISTER,
Mount Carmel, Ill., January 26, 1896.

DEAR SIR: I am not familiar enough with the traffic of White River to make definite answers to your inquiries. I have always thought the improvement of that river was of greater importance than the improvement of the Wabash, for it is from that stream that our principal supplies of logs come. In earlier years coal was brought down White River in flatboats and considerable lime was shipped the same way. In bringing out corn the river would be very valuable to the farmers in the bottoms.

* * * * * * *

Very respectfully,

FRANK W. HAVILL.

LETTER OF MR. SAMUEL A. JORDAN.

AUDITOR'S OFFICE, KNOX COUNTY,
Vincennes, Ind., January 28, 1896.

DEAR SIR: In reply to your letter of January 24, will say the principal commodities on White River are corn and wheat, and the country is full of coal from Petersburg on up the river; there was hauled by boats and loaded on cars last year at Deckers Station something like 160 cars of wheat and corn. The coal has had nothing done to it. Some five or six years ago one Rodgers, of Washington, Ind., put up a little coal elevator at Deckers on the river and handled a few cars of coal, but the water soon got too low and he soon abandoned the business.

Jordan Bros., of Deckers, Ind. (of which I am of the firm), have been in the river trade at that point for some thirteen years. We formed a packet company with Evansville and Terra Haute Railroad and ordinarily handled from 100 to 300 cars of corn and wheat each year. Altogether owing to the water we had to do our work from March 1 to June, after that time the water would get too low for us to do anything. We don't know that any production of articles would be increased, but it would increase the value of the land, inasmuch as farmers along the stream could market their produce any time they wanted to and would depend on the river as a market. As it is, they haul their grain 10 to 15 miles to market. We have now sold our boats for the reason that we could only depend on using them from two to three months each year, which was not profitable.

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Yours, respectfully,

Samuel A. Jordan.

Capt. J. G. **Warren.**

LETTER OF MR. J. R. PHILLIPS.

Hazleton, Ind., *January 31, 1896.*

Dear Sir: In answer to yours of the 24th ultimo, asking in regard to the statistics of all commodities that are produced and shipped from the section of country through which White River flows, I would say that I am not in position to answer this question with any degree of certainty.

We handle a great deal of corn from points along this river, but the amount we have shipped is but a very small part of the amount raised in this section. The principal articles produced and shipped from this valley are wheat and corn, and the production of these articles would be materially increased if the stream was made navigable at all seasons of the year.

There are some veins of coal and, I think, stone quarries along the river that the improvement of the river would cause to be developed. The rates charged by railroad companies for carrying these productions would be greatly reduced if the river could be made a competitor. The improvements of the river as an isolated waterway would be beneficial.

This is about all the information I am able to furnish on this subject.

Very respectfully,

J. R. Phillips.

Capt. J. G. **Warren.**

LETTER OF MR. THOMAS DONAHUE.

Washington, Ind., *January 27, 1896.*

Dear Sir: I have yours of January 24 instant.

In reply, White River is 4 miles west of this place. Mr. Hiram Hyatt, grain merchant, of this place, owns a little boat that plies up and down the river, hauling grain, wheat, and corn to Hyatts Switch, our station at the river, 4 miles west. All this grain is loaded into our cars and shipped to various points, but principally to Baltimore, Cincinnati, and Louisville, Ky. None of the grain reaches market by the boat.

The principal articles produced in the White River bottom are wheat and corn, and some melons. We have considerable coal here. Coal is being mined now a mile or more from the river. All the coal is moved by rail. I do not think the production would be greatly increased, if any, if the river was made navigable at all seasons, as the principal markets are east.

No stone quarries, and know of no interests along the river that could be developed unless logging and lumber. We get about 100 cars of grain a year at Hyatts Switch, which is brought up and down the river by Mr. Hyatt's boat. Our rates to Baltimore, 18½ cents per 100 pounds; to Cincinnati and Louisville, 9 cents per 100 pounds. These rates would not be affected by river competition.

Have no commercial statistics of the river during previous years.

* * * * * * *

Yours, truly,

Thomas Donahue,
Agent Baltimore and Ohio Southwestern Railway.

Capt. J. G. **Warren.**

LETTER OF MESSRS. WINEINGER & FARMER.

PORTERSVILLE, IND., *January 29, 1896.*

DEAR SIR: We are informed that you are desirous of obtaining all statistics possible as regards the traffic on White River, should the river be made navigable at all seasons.

Now, we have an inexhaustible supply of coal at this place. The coal is of a very fine quality that is now being mined, and at a depth of 60 feet is a vein of extra quality coal, the same being 6 feet in thickness; the stone is in vast quantities; from one quarry the stone was taken some years ago to be used in building the old Erie Canal, the same being taken down the river some 20 miles or more.

There is no better farming country in the State than the White River Valley, farmers raising mostly corn and wheat, oats, etc., which they must haul to nearest market, 9 miles and often 15 miles.

Another fact is that drovers purchasing stock from farmers must drive a long distance to a shipping point. The number of car loads of different stock taken from this immediate neighborhood per week is about 5 cars.

Hoping this may be of some benefit to you, we are

Yours, truly,

WINEINGER & FARMER.

J. G. WARREN.

LETTER OF MR. HENRY HOLMAN.

WILLIS, IND., *February 1, 1896.*

SIR: Will be glad to give you all the information I am in possession of concerning commodities produced in my section of the country, as per your letter of 24th instant. These answers are only approximately true, but after careful consideration they are answered to the best of my knowledge.

In this section we ship very little produce, on account of the great distance to market. Most of the produce is hauled to Vincennes (16 miles distant) and sold to dealers in that place. About four-fifths of the wheat crop, one-half of the corn, and one-half of the potato crop are marketed there. A few local shippers sell their livestock at Indianapolis and ship from Vincennes. The river is usually so low that boats can run only in the winter season, and then only corn is shipped by boat.

Wheat, corn, oats, potatoes, fruits, vegetables, and hay (clover and timothy).

Their production would be increased and a decided advantage would be gained by having the river navigable at all seasons, thus affording a near market.

Coal mines, but no stone quarries near us.

Believe railroads would lower their rates if they had any competition.

7. Yes.

8. No.

This section of the country is very fertile and nearly all under cultivation. The great drawback is the distance to market, which would be removed if White River was navigable at all seasons of the year.

* * * * * * *

Very truly, yours,

HENRY HOLMAN.

Capt. J. G. WARREN.

LETTER OF MR. L. T. PHILLIPS.

MOUNT CARMEL, ILL., *February 4, 1896.*

SIR: As I have not been in the river service for over five years I am not posted in the details you ask for. One thing I do know, that the White River should be improved so that boats can run at almost any stage of water. The land on both sides of White River is some of the best in the State, and abundance of crops are raised, both corn and wheat, with no way of shipping unless they haul to the railroads, which cross the river about 30 or 40 miles apart, with no railroad running parallel with river on either side; therefore, the farmers are compelled to make long hauls by wagon to get to the railroad—that is, when the water, with the obstructions in the river, is too low for boating. The steamer *Irene* is boating corn daily on the rise we have in the river, and the captain tells me that he has already contracted to boat 300,000 bushels of corn just as fast as he can move it.

* * * * * * *

Awaiting your further favors, I am,
Your obedient servant,

L. T. PHILLIPS.

Capt. J. G. WARREN,
United States Engineer.

LETTER OF MR. DAN MERSHON.

HIGH BANKS, PIKE COUNTY, IND., *February 12, 1896.*

Mr. WARREN.

SIR: The only correct way that I know of to get the right number of bushels of grain would be to go up one side of the river and down the other between Petersburg and Portersville and take an estimate of it. As near as I know there have been as much as 150,000 bushels wheat, 600,000 bushels corn, 200,000 bushels oats, 10,000 tons of hay, 15,000 head of cattle, and 20,500 head of hogs.

2. Shipments are made mostly by railroads.

3. Shipments are made from Petersburg, Pike County; Washington, Daviess County, and Jasper, Dubois County, by hauling grain or driving stock 18, 10, and 8 miles from river valley to place of shipment.

4. Points shipped to are Cincinnati, Louisville, Chicago, Pittsburg, New York.

5. The principal articles produced by and shipped from White River Valley are corn, wheat, oats, hay, hogs, poultry, and cattle.

6. The production of these articles would, I think, be increased and would be a great advantage to the people if the river was made navigable at all seasons of the year, as small boats come up as far as Portersville when the river is full for corn and other articles.

7. There are three or four coal mines open between the main body of White River and Portersville; fine prospect for stone quarry 1 mile west of High Banks on river bluff—such stone as the bridge is built on across this river.

8. I do not know the rates; we generally sell to speculators.

9. From the years 1860 to 1870 a man by the name of Logan carried on quite an extensive shipment from this point—High Banks—in flatboats, of such articles as I have named; also packing pork, shipping from here.

10. In 1885 a gentleman shipped from this point 15,000 bushels of wheat to Baltimore to fill a contract.

White sand and excelsior timber in abundance.

Watermelon crops are enormous.

As I have given you about all the information I can think of now, I will say to you if there is anything I can do or any information I can give you I will gladly do so. I ask pardon for not answering sooner, as I have been away from home.

Respectfully, yours,

DAN MERSHON, *Algiers, Ind.*

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LETTER OF MR. J. A. DAVIDSON.

HAZLETON, IND., *February 24, 1896.*

DEAR SIR: Mr. Decker, of this place, handed me a letter from you and asked me to write you.

I have been engaged in the grain business at this place during the past year. We have shipped during that time over 100,000 bushels of wheat and 300,000 bushels of corn.

At least two-thirds of it was raised along the river and would have been handled on the river if it had been so boats could run. There were about 70,000 bushels shipped by water. There were four other buyers here during the wheat season and one during the corn season, and I suppose they handled as much as we did.

There is coal and stone all along the river, which I believe would be worked if the river were navigable. I think it would be worth more to the country to have White River made navigable at all seasons than anything that could be done, as we get a rebate on freight for all river stuff, which enables us to pay the same along the river that we do for wagon stuff here.

The railroad rates are very high, and if the river were made navigable I believe they would cut them down so we could pay at least 2 cents more on the bushel for grain than we can now.

Hoping your report will be satisfactory and that the river will be made navigable the year round, I remain,

Yours, respectfully,

J. A. DAVIDSON.

Capt. J. G. WARREN.

LETTER OF MR. W. S. SISSON.

HAZLETON, IND., *February 29, 1896.*

DEAR SIR: In reply to your letter of January 24, 1896, to Woodburn & Spain, which was handed me by them, will say that the improvement of White River between here and Mount Carmel, Ill., where it empties into the Wabash River, will be of vastly more benefit to shippers, farmers, dealers, etc., than the local improvement that has been the custom to do a few miles on each side of the railroads, as this system of improvement only adds to the railroads' territory without opening up a competing line for shipment of produce. The difference between station rates and river rates is about 50 per cent in car lots. Unless the river is improved from one railroad crossing to another, so it will give shippers advantage of two or more lines of shipping, in my judgment the money expended will amount to nothing of a general value. The products shipped from here are corn, wheat, lumber, and fruits.

Any information I can furnish you from this locality will be cheerfully done.

Yours, respectfully,

W. S. SISSON.

Capt. J. G. WARREN.

LETTER OF MR. E. W. HOPKINS.

WASHINGTON, IND., *March 3, 1896.*

DEAR SIR: A reply to your favor of January 24 has been delayed owing to my absence from the city and our efforts to obtain the information which you desire. Our traffic department advises me as follows:

Inquiry No. 1. During the year 1895 these companies handled from the river 81 cars of grain and 14 cars of lumber, received by us at Deckers and Blackburn, and transhipped by rail to destination. The business originated on the White River and moved to local mills on our line and to Eastern points.

No. 2. We have no data showing the amount of business handled through to destination by boats, but as there are no large commercial centers on the river, the movement might be considered small.

No. 3. The principal commodities shipped are grain and lumber.

No. 4. I am quite unprepared to express the opinion as to whether the improvements of the river would increase the tonnage or not. That would depend wholly upon the development of the country immediately tributary to the river, the assumption being that the business would naturally seek the rail shipping points when such points were advantageously located.

No. 5. We are not advised of any extensive deposits of coal on the river. We understand there are a few undeveloped stone quarries, but are not in position to state the quality.

No. 6. The principal products are grain and lumber, moved to local or Eastern seaboard points. I do not see how the improvement of the river could materially affect the cost of transportation.

No. 7. Nearly if not quite all of the business contiguous to White River would ultimately find its way to rail lines.

The improvement of the river as an isolated waterway might prove beneficial to some extent in making it possible to reach markets at all seasons of the year by water and rail, but probably not otherwise. This is, of course, problematic.

No. 8. We have no data showing movements of business on the river for previous years.

Yours, truly,

E. W. HOPKINS, *Agent.*

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

LETTERS OF MR. JAMES MCBRIDE.

SHOALS, IND., *January 29, 1896.*

DEAR SIR: I received your letter of interrogatories yesterday evening. I send the following information, which I hope will be of some use to you. The following statistics are taken from the report of the secretary of agriculture of the State of Indiana:

CORN.

Corn grown in Indiana in 1892	bushels..	103,000,000
Consumed on farms where grown	do....	80,000,000
Corn shipped out of country	do....	23,000,000
Per cent shipped out of country		22

Productions of corn by counties are taken from another book by same author and is of a different date.

In 1889, which was an average year for the production of corn in Indiana, the following amounts of corn were raised in counties bordering on that part of White River which has just been surveyed, to wit:

	Bushels.
Daviess County	1,435,000
Dubois County	846,000
Gibson County	1,721,000
Knox County	2,042,000
Pike County	1,033,000
Total	7,077,000

1895 being an extraordinary good year for corn, it is estimated that 20 per cent more corn was raised than in 1889. From a long experience in farming and from a clear knowledge of the relative production of corn on river bottom land lying back of the river bottoms, I give it as my opinion that the corn produced on the hill land is consumed at home and the surplus corn which is shipped out of the country is raised in the river bottoms. Therefore I estimate that the 22 per cent of the corn that is shipped out of the counties bordering on White River is raised on the river bottom land.

I traveled over the White River bottom lands for a distance of 85 miles and found the land to be very fertile, producing from 60 to 80 bushels of corn per acre and 30 bushels of wheat per acre.

The 85 miles of river surveyed by Mr. Shanks constitute about one-half of the river within those five counties and bordering them on the west. Then it would be safe to estimate that one-half of the corn shipped out of those counties would be shipped from the bottom lands along that part of the river surveyed.

The total amount of corn raised in those five counties in 1889 is 7,077,000 bushels. Twenty-two per cent of this amount is 1,556,940 bushels, the number of bushels shipped out of the counties named.

Now, as the bottom lands along the river surveyed constitute about one-half of the bottom lands in those five counties, it is safe to estimate that one-half the corn shipped would come from the bottoms along the survey. Therefore 778,470 bushels of corn is shipped annually from the territory along that part of White River under consideration.

Another test: On a straight line from the forks to the mouth of the main river is 31.5 miles. The river bottoms will average about 3 miles in width; $31.5 \times 3 = 94.5$ square miles. From the forks to the Baltimore and Ohio Southwestern Railroad Bridge on a straight line is 8 miles. The bottoms will average about 2.5 miles wide; $8 \times 2.5 = 20$ square miles. From the forks to Portersville on a straight line is 14 miles. The bottoms will average about 1 mile in width; $14 \times 1 = 14$ square miles; $94.5 + 20 + 14 = 128.5$ square miles or sections.

Mr. Fulsche, on the river below Petersburg, has a farm of about 960 acres, or 1½ sections, on which he raised last year 17,000 bushels corn; 128.5 sections divided by 1.5 gives 85.6 such farms; $17,000 \times 85.6 = 1,455,200$ bushels corn. Estimating that about one-half of this would be consumed on the farms for feed and to fatten stock for the market, it would leave the number of bushels to be shipped about the same as obtained by the other method. I know this is the knotty point desired; therefore I have reasoned at some length to get it.

Seven hundred and seventy-eight thousand four hundred and seventy bushels corn at 20 cents per bushel = $155,694, value of corn shipped.

Nearly all of the corn on White River below Cunninghams Ferry is shipped by boat. Above that point most of it in the past few years has been shipped by rail, owing to the bad condition of the river and low water. Farmers whom I interviewed claim they can ship their grain from 5 to 10 cents a bushel cheaper by boat than by river.

Yours, truly,

JAMES MCBRIDE.

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

SHOALS, IND., *January 29, 1896.*

DEAR SIR: I send you the following additional information, which I hope will be useful to you, to wit:

WHEAT.

Wheat grown in Indiana in 1892, 40,000,000 bushels; consumed in county where grown, 17,500,000 bushels; shipped out of county where grown, 22,500,000 bushels; per cent shipped, 56. Wheat raised in counties named in 1889, to wit:

	Bushels.
Daviess County	654,000
Dubois County	402,000
Gibson County	1,469,000
Knox County	1,192,000
Pike County	461,000
Total	4,178,000

The above statistics for both State and counties are taken from the reports of the secretary of agriculture, Indiana.

Fifty-six per cent of 4,178,000 bushels, 2,339,680 bushels, equals the number of bushels shipped from those five counties in 1889.

Wheat for shipment is grown in all parts of those counties; therefore a smaller per cent of wheat would be shipped by boats than of corn.

If White River is made navigable I estimate that 500,000 bushels would be shipped from those counties by boat annually, either directly or to points where it could be shipped by rail. I was informed by farmers in the vicinity of Flat Rock Ferry, on the East Fork, that they had to haul their grain 18 miles by wagons to a point where it could be shipped by rail. It cost them 8 cents per bushel to have it hauled by wagon.

CLOVER SEED.

The report of the secretary of agriculture shows that the following amounts of clover seed were grown in the counties named in 1890; he also states that the crop of clover seed raised in 1890 was only about two-thirds of a crop compared with other years:

Clover seed, 1890.

	Bushels.
Daviess	1,415
Dubois	4,800
Gibson	4,175
Knox	2,923
Pike	3,404

I think that 80 per cent of this is shipped out of those counties. If the river was made navigable I would estimate that 20 per cent of the part shipped would be by boat. Clover seed usually sells at $5 per bushel.

WOOL.

Wool shipped in counties named in 1889, according to report of the secretary of agriculture, Indiana.

	Pounds.
Daviess County	32,000
Dubois County	16,000
Gibson County	29,526
Knox County	22,908
Pike County	31,835

Wool sold last year at 14 cents per pound.

HOGS.

Hogs fattened in 1889 in counties named.

[Taken from Report of Secretary of Agriculture, Indiana.]

	Head.
Daviess County	23, 242
Dubois County	13, 727
Gibson County	30, 582
Knox County	36, 875
Pike County	19, 047

Hogs are worth 3 cents per pound, gross.

Hogs slaughtered in counties named, 1889.

	Head.
Daviess County	8, 154
Dubois County	9, 895
Gibson County	11, 992
Knox County	30, 838
Pike County	8, 862

A part of these are for home consumption; some for market by local packers.

COAL.

If White River was made navigable, this would be the greatest item of all. In my opinion, millions of bushels would be shipped to New Orleans and intermediate cities by boats, bringing much wealth into the country and furnishing employment for labor.

Judging from the evidences in the mines already developed and in operation, and in those opened by prospectors, and the coal blossom which may be seen along the survey, I think nearly all the country along the east side of the West Fork, both sides of the East Fork, and the south side of the main river for several miles below the forks is underlayed with coal.

I have no statistics at hand on this subject, but think you can get all the information you need from the State geologist, Indianapolis, Ind.

Believing that the improvement of White River would be a lasting benefit to the people along its shores,

I am, yours truly,

JAMES MCBRIDE.

Capt. J. G. WARREN,
Corps of Engineers, U. S. A.

E E 13.

SURVEY OF GREEN RIVER, KENTUCKY, AT OR NEAR ITS MOUTH FOR NEW LOCK AND DAM.

[Printed in House Doc. No. 30, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 17, 1897.

SIR: I have the honor to submit the accompanying copy of letter dated April 3, 1897, from Maj. James F. Gregory, Corps of Engineers, together with copy of his report of same date, upon the results of a survey of Green River, Kentucky, at or near its mouth, for new lock and dam, made in compliance with the provisions of the river and harbor act of June 3, 1896.

Major Gregory states that the most serious shoal at low water between Lock No. 1 and the mouth of the river extends for about a mile downstream from the lock, and that the only practicable location for a lock and dam below this shoal is about a mile and a half above the river's mouth.

The only other practicable location for a lock is at the west end of

Dam No. 1, on the opposite side of the island from the present lock, and if this portion of the river is to be improved by a new lock and dam it is the opinion of Major Gregory that the location at the west end of Dam No. 1 is the most suitable one. Such a lock should have at least 3 feet more water on the lower miter sill than the present one, and should be 190 feet between hollow quoins with a width of chamber of 52 feet. This depth on the lower miter sill, with excavations below, will insure at least 4 feet of water at the lowest known stage in the Ohio River, and 8 feet at ordinary low water. The cost of a concrete lock of this character, with appurtenances, if built at the upper location so that the present dam may be used therewith, is estimated at $228,717.50. The cost of a similar lock with dam and cribs, if built at the lower location, is estimated at $294,800. The relative merits of the two locations proposed are presented in the report.

For the reasons given, Major Gregory is of the opinion that the proposed improvement is not at present justified by the interests of commerce involved, and his views are concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, April 3, 1897.

GENERAL: In compliance with instructions contained in letter from the office of the Chief of Engineers, United States Army, dated September 5, 1896, I have the honor to transmit herewith report upon the survey of "Green River, Kentucky, at or near its mouth, for new lock and dam," accompanied by three tracings of maps* of survey.

The desire for additional improvements near the mouth of this river has been manifest mainly among those interested in a prospective coal trade, who complain that the depth of water on the lower miter sill at Lock No. 1 (5.5 feet at ordinary Ohio low water) is insufficient to enable barges that must compete with more favorable districts to reach the Ohio. They also complain that the upper entrance to this lock is of such an inconvenient nature—being long, narrow, and not straight—as to cause expensive delays in shipment. What is desired are sufficient facilities at Lock No. 1 to enable barges drawing 6 to 7 feet to easily reach at all seasons the deep water below Lock No. 1 from the upper part of the river where the coal is mined, so that in favorable stages in the Ohio these coal barges can then be floated out for the Southern market. It is said that the development of this trade is to a great extent dependent on the construction of a new lock of greater capacity than the present lock, and with a greater depth of water on the lower miter sill.

With regard to the greater lock capacity required, in examining the present commerce of the river it appears that at no time, except perhaps during a short period of high water in the logging season, is the lock ever worked to its full capacity, so that even if the present commerce were to be increased many times the present size would accommodate all demands upon it.

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*Not printed.

With regard to the depth of water on the lower miter sill, reference is invited to tables showing the depths of water on the sill during each year from 1889 to 1897, contained in the accompanying report of Mr. G. F. Stickney, assistant engineer, dated February 10, 1897. From these tables it appears that during seven months of the year there is sufficient water in the Ohio to enable coal to be brought out of Green River. Of this condition no advantage whatever has been or is being taken.

The coal developments on Green River thus far are sufficient for a good local supply, and that is about all. Mining coal for shipment out of Green River by way of the Ohio River is wholly prospective, and the immediate future does not at present promise much in that direction; otherwise efforts would be made to utilize the present very fair navigation facilities afforded by the existing river improvements.

Apparently, therefore, the desire for a new lock at this part of Green River is prompted not so much by a wish to help an already existing and hampered trade, but rather as an inducement offered by owners of coal interests to outside enterprise.

For the above reasons I can not but come to the conclusion that the proposed improvement is not at present justified by the interests of the commerce involved.

For details of estimates, discussion of tables, commercial statistics, and lock locations, reference is invited to report of Mr. G. F. Stickney, above alluded to.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, April 10, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

As Major Gregory reports that the increased depth is required only by the coal trade, and that no use is made by that trade of the present facilities, which are suitable for seven months of the year, and as there is no evidence that if larger locks were built they would be utilized by the coal trade, I concur in Major Gregory's opinion that the proposed improvement is not at present justified.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, April 3, 1897.

GENERAL: In compliance with instructions contained in the letter from the office of the Chief of Engineers, United States Army, dated September 5, 1896, directing a survey of "Green River, Kentucky, at or near its mouth, for a new lock and dam," as required by act of Congress of June 3, 1896, I have the honor to make the following report:

The field work of this survey was commenced October 20 and completed November 22, 1896, by Mr. G. F. Stickney, assistant engineer. A preliminary survey was first made, commencing at the mouth of the river and extending above Lock No. 1, a distance of 9 miles, taking soundings up the middle of the river and across it at about 1,000-foot intervals, to determine the existence and location of shoals. Borings to rock were made at places suitable for a lock and dam.

The river has a width, at its mouth, of 530 feet, which is gradually reduced to 400 feet in the first 2 miles, and this width it holds with but slight variation up to Lock No. 1. Throughout this distance it has a depth varying from 11 to 30 feet, except on the shoals. The first shoal is at the mouth of the river and is of soft mud, which is deposited in the quiet water of Green River when the Ohio is high and the Green River low, and it is cut out again when the Green is high and the Ohio low. The existence of this shoal depends on conditions that can not be affected by a lock and dam in the Green River, and will likely always require more or less dredging to accommodate deep-draft boats. The second shoal is just below Race Creek, 3 miles above the mouth of the river, and is of rock. It extends only about to the middle of the river, and having deep water beyond to the other bank, does not offer much serious obstruction to navigation. The third shoal is at Lock No. 1, and is a part of the rock foundation on which that lock rests. This shoal extends for about a mile downstream below the lock, and has from 5½ to 10 feet of water on it. This is the most serious shoal at low water below Lock No. 1. The only practicable location for a lock and dam below this shoal, where the river is wide enough to give sufficient spillway for a dam, and where the depth to rock is not too great, is about a mile and a half above its mouth. The main advantage of this location would be the giving of plenty of water over all the shoals above this location as far as Lock No. 1. The disadvantages would be (1) the extra cost of foundations due to depth to rock; (2) the low-lying banks, which are often submerged, allowing the Ohio, at extreme high water, to cut across this part of the land, and thus, perhaps, endanger the lock if constructed; (3) decreasing the clear headway under the Louisville, Henderson and St. Louis Railroad Bridge, requiring the draw to be opened in many cases when not now necessary; (4) diminishing the present use of the lower part of the river as a harbor for rafts and vessels during the winter, and (5) closing the river to navigation during its construction.

The only other practicable location for a lock is at the west end of Dam No. 1, on the opposite side of the island from the present lock. The disadvantage of this location would be the necessary excavation of a channel partly through rock for about 2,000 feet below this lock, to get sufficient depth in the lower entrance. The advantages, on the other hand, would be (1) that the river here is about 550 feet wide, giving plenty of spillway to the dam; (2) the rock is found at an average depth of about 3 feet, making the foundations cheaper and simpler; (3) the land already belongs to the United States; (4) the present dam and abutment can be used; (5) navigation need not be stopped during construction; (6) the entire river below can be used as a harbor for rafts and vessels in the winter while the Ohio is full of ice.

If this portion of the river is to be improved by a "new lock and dam" it is my opinion that the location at the west end of Dam No. 1 is the most suitable one.

This lock should have at least 3 feet more water on the lower miter sill than the present one, and should be 190 feet between hollow quoins, with a width of chamber of 52 feet. This depth on the lower miter sill, with excavations below, will insure at least 4 feet of water at the lowest known stage in the Ohio River and 8 feet at ordinary low water. The other dimensions as given will probably give ample facilities for many years to come.

The estimated cost of a concrete lock of the dimensions given above and its appurtenances, if built at the upper location, so that the present dam may be used therewith, is as follows:

Lock.

Cofferdam 600 feet long, at $10 per linear foot	$6,000.00	
Excavating for foundation, 9,300 cubic yards solid rock, at $1.25 per cubic yard	11,625.00	
Masonry of lock, 13,600 cubic yards, at $9 per cubic yard	122,400.00	
Lock gates, operating irons, etc	13,000.00	
		$153,025.00

Cribs.

Guide cribs, aggregating 500 linear feet (16 feet wide, 30 feet high), at $37 per linear foot	18,500.00

Channel.

Excavating channel below lock (60 feet wide, 9 feet deep, about 2,000 feet long):		
Gravel, about 4,000 cubic yards, at 10 cents per cubic yard.	$400.00	
Solid rock, about 9,000 cubic yards, at $4 per cubic yard.	36,000.00	
		36,400.00
Contingencies, 10 per cent		20,792.50
Total for new lock at upper location		228,717.50

The estimated cost of a concrete lock of the dimensions given above, complete, if built at the lower location, including cribs and a new dam, complete, is as follows:

Lock.

Dredging foundation for lock, 20,000 cubic yards, at 10 cents per cubic yard	$2,000	
Cofferdam, 600 linear feet, at $15 per linear foot	9,000	
Masonry of lock, 16,000 cubic yards, at $9 per cubic yard	144,000	
Lock gates, operating irons, etc	13,000	
		$168,000

Cribs.

Guide cribs, aggregating 500 linear feet (16 feet wide, 35 feet high), at $43 per linear foot	21,500

Abutment.

Dredging foundation for abutment, 5,000 cubic yards, at 10 cents per cubic yard	$500	
Cofferdam, 100 linear feet, at $15 per linear foot	1,500	
Masonry of abutment, 2,500 cubic yards, at $9 per cubic yard	22,500	
		24,500

Dam.

Dredging foundation and backing for dam, 30,000 cubic yards, at 10 cents per cubic yard	3,000	
Dam, 450 feet long, 60 feet wide	51,000	
		54,000
Contingencies, 10 per cent		26,800
Total for new lock and dam at lower location		294,800

The following tracings of the maps of the survey are herewith transmitted, viz:

1. Survey of Green River, Kentucky, from its mouth to Lock No. 1.
2. Survey of Green River, Kentucky, at Lock No. 1.
3. Survey of Green River, at Lock No. 1, cross sections.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. G. F. STICKNEY, ASSISTANT ENGINEER.

BOWLING GREEN, KY., *February 10, 1897.*

MAJOR: I have the honor to submit the following report in regard to survey for new lock and dam at or near the mouth of Green River, Kentucky. The desire for a new lock at or near the mouth of Green River evidently arises from the fact that during an extreme low stage of water in the Ohio River the depth of water over the lower miter sill of the present lock is not sufficient to allow the passage of boats. The following tables, prepared from the records of gauge readings during the past eight years, show the depth of water, and also the season of the year during which the lowest stages occur:

Depth of water on lower miter sill at Lock No. 1, Green River, Spottsville, Ky., from January 28, 1889, to January 28, 1897, during each year.

Year.	8 feet and over.	7 feet and over.	6 feet and over.	5 feet and over.	4 feet and over.	3 feet and over.	2 feet and over.	1 foot and over.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
1889	292	301	320	335	338	365	365	365
1890	353	360	365	365	365	365	365	365
1891 *	282	283	284	290	309	331	365	365
1892	240	262	290	303	330	344	366	366
1893	262	302	321	344	352	365	365	365
1894	197	214	241	251	266	318	365	365
1895	181	221	245	274	295	307	330	365
1896	339	342	345	362	366	366	366	366
1897	*a* 27	......	......	......	......	......	......	......
Total	2,173	2,285	*b* 2,411	2,524	2,621	2,761	2,887	2,922

By adding together the two items in the above table indicated by *a* and *b* the total number of days during the eight years on which there were 6 or more feet of water on the lower miter sill is found to have been 2,438, or an average of 304¾ days in each year.

Depth of water on lower miter sill at Lock No. 1, Green River, Spottsville, Ky., from January 28, 1889, to January 28, 1897, during each month.

Month.	Total days per month for eight years.	8 feet and over.	7 feet and over.	6 feet and over.	5 feet and over.	4 feet and over.	3 feet and over.	2 feet and over.	1 foot and over.
	Days.	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
January	248	239	248	248	248	248	248	248	248
February	228	212	228	228	228	228	228	228	228
March	248	248	248	248	248	248	248	248	248
April	240	240	240	240	240	240	240	240	240
May	248	248	248	248	248	248	248	248	248
June	*f* 240	216	222	*e* 231	240	240	240	240	240
July	248	182	205	225	230	244	248	248	248
August	248	122	149	173	196	211	248	248	248
September *	210	48	60	86	136	160	186	210	210
October *	244	82	99	113	127	162	194	227	244
November	240	125	135	154	164	173	187	222	240
December	*d* 248	211	232	*c* 246	248	248	248	248	248

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* Record taken for 1891 is incomplete, as no gauge readings were taken from September 1 to October 4, inclusive.

From the last above table it is found that for seven consecutive months in each year, December to June inclusive, there have been but eleven days during the eight years when there were not 6 or more feet of water over the lower miter sill, viz: Item *c* deducted from item *d* leaves two days, and item *e* deducted from item *f* leaves nine days.

The above tables show also that the low-water season occurs during the months of September, October, and November.

The commerce of Green River may be divided into four classes, of which the following gives the percentage of each, as shown by the commercial statistics collected during the past nine years:

	Per cent.
Timber, logs, etc., rafted	71½
Coal, transported in barges	9½
Railroad ties, staves, etc., transported in barges	9½
Produce, hay, grain, tobacco, and miscellaneous merchandise, carried by packets	9½
Total	100

The timber, logs, etc., are rafted during the high-water season, as a high stage is necessary before they can be brought out of the numerous small creeks, branches, etc., into the main river, and they have ample time to reach the deep portion of the river, below the lock, before the low-water season. The records show that practically no coal passes through the lock, the coal noted being transported on the upper portion of the river. The railroad ties, staves, etc., are carried almost entirely during the high-water season, the cutting and hauling to the river being done during the summer and fall. Of the produce, grain, hay, tobacco, and miscellaneous merchandise, hardly one-fifth is transported during the months of September, October, and November. Thus, less than 2 per cent of the commerce of the river is liable to be affected by the stoppage of navigation on account of an insufficient depth of water over the lower miter sill at the present lock.

It has been asserted that the development of the coal interests along Green River is, to a great extent, dependent on the construction of a new lock of greater capacity than the present structure, having a greater depth of water over the miter sills, in order that barges may be loaded at the mines during the low-water season, taken to the mouth of the river, where they may be held in safety in the deep water there, and where they will be ready to be made into fleets to be taken to the Southern market as soon as there is a sufficient stage of water in the Ohio River. Inasmuch as within recent years no attempt has been made to transport coal from above the lock to points beyond the river, although such a project is entirely feasible for at least seven months of each year, I am of the opinion that the needs of commerce at the present time do not justify the construction of a new lock.

Should the river interests become of such importance as to make a new lock at this point necessary, I would respectfully recommend that it be made of much larger capacity than the present lock, and that it should have an ample depth of water over the lower miter sill. A lock 190 feet long between hollow quoins 52 feet wide, with its lower miter sill 3 feet lower than that at the present lock, would answer all requirements, and would insure a depth of at least 4 feet at the lowest stage known.

Of the two locations noted in my report* of January 2, 1897, the upper site, i. e., at the west end of Dam No. 1, is undoubtedly the most desirable, for the following reasons: Less cost of construction for lock proper and guide cribs; the dam and abutment are already built; the necessary land is owned by the United States; there is high land in the vicinity, above the possibility of overflow, for the lock master's dwelling and for storing supplies; the place is easy of access, being on line of railroad; a new lock can be constructed here without interrupting navigation, and almost the entire river below the lock will be available as a harbor. The only objection to this location is found in the shoal below the lock, through which a channel about 2,000 feet long would have to be excavated from the lower end of lock extending to deep water.

It should be noted that the lower part of the river is at present used during the greater part of the year as a harbor for rafts, which at times occupy both banks for a distance of 4 miles or more, and that during the winter, when the Ohio is full of ice, many boats come to Green River for a harbor of refuge.

The lower location, about 1½ miles above the mouth of Green River, would have the advantage of making deep water over the shoal below the present lock, which is the strongest point in its favor. Solid rock is here found at an average depth of 17 feet. The disadvantages of this location, as compared with the first, are as follows: Greater cost of construction of lock proper and of guide cribs, on account of greater depth of solid rock; cost of dam and abutment; the water level would be raised 16.6 feet under the Louisville, Henderson and St. Louis Railroad Bridge, requiring the opening of the draw of bridge for boats which are now able to pass underneath; the surrounding land is liable to overflow; there would not be a sufficient length of river below the lock available as a harbor; and if a lock and draw were constructed here the river would necessarily be closed to navigation at this point while the dam was being built.

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* Not transmitted.

The upper location is evidently so much the more desirable, that I have no hesitation in recommending it as the best site for a new lock.

In the following estimates of the cost of building a new lock, or new lock and dam, to take the place of the present structure, I have assumed the lock to be built of concrete, to be 190 feet long between hollow quoins, width of chamber 52 feet, and depth of water on lower miter sill 8 feet.

Upper location.

Lock:		
Cofferdam 600 feet long, at $10 per linear foot	$6,000	
Excavating for foundation, 9,300 cubic yards solid rock, at $1.25 per cubic yard	11,625	
Masonry of lock, 13,600 cubic yards, at $9 per cubic yard	122,400	
Lock gates, operating irons, etc	13,000	
		$153,025.00
Cribs:		
Guide cribs, aggregating 500 linear feet (16 feet wide, 30 feet high), at $37 per linear foot		18,500.00
Channel:		
Excavating channel below lock (60 feet wide, 9 feet deep, about 2,000 feet long):		
Gravel, about 4,000 cubic yards, at 10 cents per cubic yard	$400	
Solid rock, about 9,000 cubic yards, at $4 per cubic yard	36,000	
		36,400.00
Contingencies, 10 per cent		20,792.50
Total for new lock at upper location		228,717.50

Lower location.

Lock:		
Dredging foundation for lock, 20,000 cubic yards, at 10 cents per cubic yard	2,000	
Cofferdam, 600 linear feet, $15 per linear foot	9,000	
Masonry of lock, 16,000 cubic yards, at $9 per cubic yard	144,000	
Lock gates, operating irons, etc	13,000	
		$168,000
Cribs:		
Guide cribs, aggregating 500 linear feet (16 feet wide, 35 feet high), at $43 per linear foot		21,500
Abutment:		
Dredging foundation for abutment, 5,000 cubic yards, at 10 cents per cubic yard	$500	
Cofferdam, 100 linear feet, at $15 per linear foot	1,500	
Masonry of abutment, 2,500 cubic yards, at $9 per cubic yard	22,500	
		24,500
Dam:		
Dredging foundation and backing for dam, 30,000 cubic yards, at 10 cents per cubic yard	3,000	
Dam, 450 feet long, 60 feet wide	51,000	
		54,000
Contingencies, 10 per cent		26,800
Total for new lock and dam at lower location		294,800

Respectfully submitted.

G. F. STICKNEY, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

APPENDIX F F.

IMPROVEMENT OF CERTAIN RIVERS IN KENTUCKY AND WEST VIRGINIA, AND OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Kentucky River, Kentucky.
2. Operating and care of locks and dams on Kentucky River, Kentucky.
3. Tug Fork of Big Sandy River, West Virginia and Kentucky.
4. Levisa Fork of Big Sandy River, Kentucky.
5. Big Sandy River, West Virginia and Kentucky.
6. Guyandotte River, West Virginia.
7. New River, Virginia and West Virginia.
8. Gauley River, West Virginia.
9. Elk River, West Virginia.
10. Great Kanawha River, West Virginia.
11. Operating and care of locks and dams on Great Kanawha River, West Virginia.
12. Little Kanawha River, West Virginia.
13. Operating and care of locks and dams on Little Kanawha River, West Virginia.

UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, July 17, 1897.

GENERAL: I have the honor to transmit herewith annual reports of operations for the works under my charge at the close of the fiscal year ending June 30, 1897.

First Lieut. William W. Harts, Corps of Engineers, has been on duty under my immediate orders during the entire year.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

F F 1.

IMPROVEMENT OF KENTUCKY RIVER, KENTUCKY.

The project for the improvement of this stream was adopted in 1879, consequent to the report in the Annual Report of the Chief of Engineers for 1879 (pp. 1398–1421) and provided for repairing the five old locks and dams, built by the State of Kentucky many years ago, and for extending slack-water navigation upstream to the Three Forks, 261 miles above the mouth of the Kentucky, in the Ohio, at Carrollton, Ky., by the construction of additional locks and dams. The work during the past years has resulted in repairing and rebuilding the five old locks and dams and their appurtenances, the construction of Lock and Dam No. 6, extending slack water up to High Bridge, Ky., 121 miles above Carrollton, and the partial construction of Lock No. 7.

During the past year work has been in progress at Lock and Dam No. 7, at High Bridge, Ky., in completing the river and land walls of the lock and lock gates, and in the commencement of the construction of Dam No. 7.

For details of the work done during the past season, attention is invited to the report of First Lieut. William W. Harts, Corps of Engineers, herewith, which, together with the report of the Chief of Engineers for 1896 (pp. 2286–2292) gives a good description of the progress of the work of constructing Lock and Dam No. 7.

In compliance with instructions, I submitted to the Chief of Engineers, August 24, 1896, a report upon the advisability of extending slack-water navigation in the Kentucky River beyond the pool which will be formed by Dam No. 7. This report showed that such improvement would greatly exceed the amount contemplated in the present approved estimate (Annual Report, Chief of Engineers, 1883, pp. 1561, 1562).

Money statement.

July 1, 1896, balance unexpended		$247,559.12
Amount appropriated by sundry civil act approved June 4, 1897		200,000.00
		447,559.12
June 30, 1897, amount expended during fiscal year		178,898.74
July 1, 1897, balance unexpended		268,660.38
July 1, 1897, outstanding liabilities	$12,689.77	
July 1, 1897, amount covered by uncompleted contracts	2,557.68	
		15,247.45
July 1, 1897, balance available		253,412.93
Amount (estimated) required for completion of existing project		1,066,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		125,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations.

March 3, 1879	$100,000	June 3, 1896	$50,000
June 14, 1880	100,000	June 3, 1896 *	83,000
March 3, 1881	125,000	June 4, 1897	200,000
August 3, 1882	225,000		
July 5, 1884	250,000	Total	1,955,500
August 5, 1886	187,500	Received from Tabor & Cogar, October, 1888	500
August 11, 1888	180,000		
September 19, 1890	180,000		
July 13, 1892	150,000	Total	1,956,000
August 18, 1894	125,000		

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* Made available November 20, 1896.

Abstract of proposals received and opened March 6, 1897, for furnishing and delivering at the site of Lock No. 7 white-oak or yellow-pine timber for improving Kentucky River, Kentucky.

No.	Name and address of bidder.	207,000 feet B. M. white oak or yellow pine (per 1,000 feet).	Total.
1	Atlanta Lumber Co., Atlanta, Ga	$20.65	$4,274.55
2	Estabutchie Lumber Co., Estabutchie, Miss	18.00	3,726.00
3	Inter-State Lumber Co., Chattanooga, Tenn	17.50	3,622.50
4	T. J. Congleton & Bro., Frankfort, Ky	18.50	3,829.50
5	Chas. F. Luehrmann Hardwood Lumber Co., St. Louis, Mo	19.50	4,036.50
6	Edw. E. Moberly, Chicago, Ill	18.75	3,881.25
7	High Bridge Lumber Co., High Bridge, Ky	17.40	3,601.80
8	Matthew B. Farrin, Winton Place, Ohio	19.25	3,984.75
9	Enterprise Lumber Co., Atlanta, Ga	16.40	3,394.80
10	A. B. Donaldson, Carrollton, Ky	19.00	3,933.00
11	Eppinger & Russell Co., New York, N. Y	20.00	4,140.00

Contract awarded Enterprise Lumber Company, of Atlanta, Ga.

Abstract of proposals received and opened March 6, 1897, for furnishing and delivering at the site of Lock No. 7 yellow pine timber for improving Kentucky River, Kentucky.

No.	Name and address of bidder.	530,000 feet B. M. yellow pine timber, per 1,000 feet.	Total.
1	Atlanta Lumber Co., Atlanta, Ga	$22.50	$11,925.00
2	Estabutchie Lumber Co., Estabutchie, Miss	17.00	9,010.00
3	Interstate Lumber Co., Chattanooga, Tenn	17.50	9,275.00
4	T. J. Congleton & Bro., Frankfort, Ky	18.50	9,805.00
5	Charles F. Luehrmann Hard Wood Lumber Co., St. Louis, Mo	19.9706	10,584.44
6	Edw. E. Moberly, Chicago, Ill	18.75	9,937.50
7	High Bridge Lumber Co., Highbridge, Ky	a 18.90 b 17.40	1,001.70 8,299.80
8	Matthew B. Farrin, Winton Place, Ohio	18.75	9,937.50
9	Enterprise Lumber Co., Atlanta, Ga	16.40	8,692.00
10	A. B. Donaldson, Carrollton, Ky	a 21.50 b 19.00	1,139.50 10,070.00
11	Eppinger & Russell Co., New York, N. Y	19.80	10,494.00

a Lot A. *b* Lot B.

Contract awarded Enterprise Lumber Company, of Atlanta, Ga.

Abstract of proposals received and opened May 1, 1897, for furnishing and delivering at the site of Lock No. 7 certain iron and steel work for improving Kentucky River, Kentucky.

No.	Name and address of bidder.	Cast iron, 25,000 pounds.		Cast steel, 320 pounds.		Wrought iron and steel, 52,000 pounds.		Total.
		Per pound.	Amount.	Per pound.	Amount.	Per pound.	Amount.	
		Cents.		*Cents.*		*Cents.*		
1	Atlanta Machine Works, Atlanta, Ga	$3\frac{1}{2}$	$875.00	$3\frac{1}{2}$	$11.20	$5\frac{1}{4}$	$2,730.00	$3,616.20
2	Thompson C. Gill & Co., Philadelphia, Pa	$4\frac{24}{100}$	1,060.00	$4\frac{24}{100}$	13.568	$7\frac{74}{100}$	4,024.80	5,098.37
3	Chattanooga Car and Foundry Co., Chattanooga, Tenn	3	750.00	3	9.60	$4\frac{6}{10}$	2,392.00	3,151.60
4	Fort Pitt Bridge Works, Pittsburg, Pa	$4\frac{44}{100}$	1,110.00	$4\frac{44}{100}$	14.21	$4\frac{74}{100}$	2,464.80	3,589.01
5	Weimer Machine Works Co., Lebanon, Pa	$3\frac{7}{8}$	968.75	8	25.60	$6\frac{1}{2}$	3,380.00	4,374.35
6	J. G. Wagner Co., Milwaukee, Wis	$3\frac{8}{10}$	950.00	$3\frac{8}{10}$	12.16	$4\frac{9}{10}$	2,548.00	3,510.16
7	John P. McGuire, Cleveland, Ohio	.024	600.00	.024	7.68	.0375	1,950.00	2,557.68

Contract awarded John P. McGuire, Cleveland, Ohio.

Abstract of contracts for improving Kentucky River, Kentucky, in force during the fiscal year ending June 30, 1897.

Contractor.	Nature of contract.	Date.	To expire.
Enterprise Lumber Co.	Furnishing timber	Mar. 29, 1897	[a] Aug. 1, 1897.
John P. McGuire	Cast iron and steel, wrought iron and steel.	May 14, 1897	July 1, 1897.

[a] Two contracts. Completed in June, 1897.

REPORT OF FIRST LIEUT. WILLIAM W. HARTS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Highbridge, Ky., June 30, 1897.

MAJOR: I have the honor to submit the following report of work done upon the improvement of the Kentucky River, Kentucky, during the fiscal year ending June 30, 1897:

The principal work of the year was the continuation of the construction of the new lock and dam in the vicinity of Highbridge, Ky., being the seventh in the series now in operation on the Kentucky River.

The following is a brief synopsis of the work done on this lock during the previous year, for more detailed statement of which see Annual Report of the Chief of Engineers for 1896, pages 2290 to 2292.

A cofferdam, 529 feet long in all, was commenced March 29, 1896, and completed June 7, 1896. The cost of this coffer was $6,693.23, or an average of $12.65 per linear foot.

On March 29, 1896, dredging was commenced for the foundation of lock walls and stopped on June 7, 1896, 37,340 cubic yards of material having thus been removed, at a cost of $3,248.58, or an average of $0.0858 per cubic yard. After the coffer was pumped out, June 8, 1896, 12,403 cubic yards more of earth and stone were removed by using wheelbarrows and derricks, at a total cost of $4,465.05, or an average of $0.364 per cubic yard.

The tramway, railroad, and derricks were built and placed in position and a portion of the stone was received.

The excavation for foundation of abutment was begun May 15, 1896. It is 70 feet long, 29 feet high, with a return wing to bank 24 feet long, and is built on and against the solid rock. It contains 349 cubic yards of stone, and cost in all $6,572.56, an average of $17.16 per cubic yard in place, including excavation.

The following is a summary of the work done during the past fiscal year:

On July 4, 1896, the cofferdam having been previously completed and pumped out, and excavation enough having been done to commence laying stone in foundation walls, the river rose and flooded the coffer. It remained submerged until July 22, 1896, when it was again pumped. When the river flooded the cofferdam it washed out the bank at the upper shore end, which breach was repaired by placing a piece of timber across and driving sheet piling, and backing it all with 5,358 cubic yards of earth, gravel, and small stone. The cost of these repairs was $920.88.

The coffer was pumped out again July 22, 1896, and 7,863 cubic yards of mud, deposited by rise in river, was hoisted out by derricks, at an expense of $2,059.04, an average of $0.262 per cubic yard. After the deposit was removed, 11,543 cubic yards of earth and stone were further removed from the river bottom to prepare the foundation for lock walls, all at an expense of $4,155.48, an average of 36 cents per cubic yard, making total excavation 69,671 cubic yards, at a total cost of $13,902.36, or a general average of $0.199 per yard.

The first stone was laid in the foundation for lock walls August 4, 1896, and the foundation entire was completed August 20, 1896.

The dimensions of the foundations are as follows: The walls are each 256 feet long, the river wall being 24 feet 3 inches wide at ends and 19 feet wide in the central narrow part, the land wall being 23 feet 3 inches and 18 feet wide in corresponding places. The space between these walls was built solid from the upper end of the walls as far down as the breast wall, or 47 feet. A cross wall 20 feet wide for foundation of the lower miter sill was also built. The depth of the foundation was mainly 8 feet, but was increased to 12 feet in several places, the average depth being 8 feet 8 inches. The amount of backing set in this foundation was 4,043.6 cubic yards, or about 252 cubic yards per day. The stone in the foundation was mainly freestone from Rowan and Rockcastle counties, Ky., and partly limestone from

Beattyville, Ky. The mortar was made of Louisville hydraulic cement, mixed 1 part to 2 of sand, which was dredged in the river near Highbridge, and the spalls were blasted out of the neighboring cliffs.

Cost of foundation.

Materials:	
Backing stone, 4,043.6 cubic yards, at an average cost of $6.50 per cubic yard	$26,283.40
Cement, 2,427 barrels, at $1.175 (including inspection)	2,851.72
Spalls, 600 cubic yards, at $0.4184 per cubic yard	251.04
Sand, 485 cubic yards, at $0.173 per cubic yard	83.90
Labor:	
Labor (including superintendence, mixing mortar, handling spalls and cement, and screening sand)	1,538.53
Transporting 4,043.6 cubic yards of stone from yard to walls, at $0.264 per cubic yard	1,067.51
Laid 4,043 cubic yards of stone, at $0.794 per cubic yard	3,210.62
Total	35,286.72

An average of $8.75 per cubic yard in place.

Laying stone in lock walls was commenced August 21, 1896, but was discontinued on account of lack of funds October 9, 1896, upon the completion of Course K, leaving nine courses to be laid beside the coping.

The stone for the inside faces of the lock, the coping, and specials are of oolitic limestone from Indiana, and the backing is mainly of Kentucky freestone, some Beattyville limestone being used. The face stones are laid in Portland cement 3 feet back from the face and the backing is laid in Louisville cement, all voids being masoned up. The miter-sill stones are all laid in Portland cement throughout and are doweled to each other with steel bolts 1¼ inches in diameter. The pointing of all exposed seams is driven in with a hammer and afterwards polished.

The following amounts of stone were laid up to October 9, 1896:

	Cubic yards.
Backing	4,170
Special	421.07
Dressed face	760.63
Dressed face, cut to ladderways, corners, etc	181.37
Quarry face	1,074.19
Pointed face	218.80
Total	6,826.06

On May 1, 1897, work was resumed, preparing plant, rigging derricks, setting engines, cutting stone, etc. All stone corners, ladderways, etc., were cut, completing all stone cutting except closures and other incidental work before commencing laying stone, which was commenced May 22, 1897, and is still in progress. The land wall is now completed, except a small portion of the coping and wing walls, and the river wall is completed up to Course K, or within ten courses of the top, or nearly one-half done.

The following amount of stone has been set up to the end of the fiscal year:

	Cubic yards.
Backing	5,318.04
Special	457.73
Dressed face	1,039.20
Dressed face, cut to ladderways, corners, etc	275.46
Quarry face	1,173.74
Pointed face	218.80
Coping	20.22
Total	8,503.19

Cost of above masonry and cost of cutting stone, including superintendence:

Materials:	
Stone, backing, 5,318.04 cubic yards, at $6.509 per cubic yard	$34,615.12
Stone, special, 457.73 cubic yards, at $14.50 per cubic yard	6,637.08
Stone, dressed face, 1,039.20 cubic yards, at $13.90 per cubic yard	14,444.88
Stone, dressed face, ladderways, corners, 282.47 cubic yards, at $13.90 per cubic yard	3,926.33
Stone, backing cut to quarry face, 1,298.20 cubic yards, at $5.50 per cubic yard	7,140.10

Materials—Continued.	
Stone, backing cut to pointed face, 269.80 cubic yards, at $5.50 per cubic yard	$1,483.90
Stone, coping, 20.22 cubic yards, at $13 per cubic yard	262.86
Cement, "Star," 3,667 barrels, at $1.175 per barrel	4,308.72
Cement, "Atlas" Portland, 769 barrels, at $2.64 per barrel	2,030.16
Spalls, 1,362 cubic yards, at $0.312 per cubic yard	424.94
Sand, 1,473 cubic yards, at $0.079 per cubic yard	116.37
Labor:	
Cutting 2,824 cubic yards, dressed face, into ladderways, corners, etc., at $5.95	1,680.69
Cutting 1,173.74 cubic yards, quarry face, at $4.015	4,712.56
Cutting 218.80 cubic yards, pointed face, at $4.015	878.48
Removing from yard to lock walls 8,506.14 cubic yards, at $0.3214 per cubic yard	2,733.87
Mixing and handling mortar, spalls, and sand, at $0.203 per yard of masonry	1,726.74
Setting 8,516.14 yards of stone, at $0.82844 per cubic yard	7,055.11
Total	94,177.91

Average cost of stone in wall, not including foundation, $11.1184.

Cost of cutting stone:	
Dressed face, 111.71 cubic yards, at $9.23	1,031.08
Thin backing, 530.55 cubic yards, at $2.13	1,130.07
Thick backing, 509.63 cubic yards, at $1.83	932.62
Quarry face, 1,450.30 cubic yards, at $4.015	5,822.95
Pointed face, 218.81 cubic yards, at $6.05	1,323.80
Dressed face, cut to ladderways, corners, etc., 307.59 cubic yards, at $5.95	1,830.16
Total	12,070.68

Average cost of cutting per cubic yard, $3.90.

It is thus seen that the average cost of all masonry to date has been $10.365 per cubic yard, made up as follows:

	Per cubic yard.	Total.
Stone, including cutting, 12,549.20 cubic yards	$8.171	$102,539.51
Handling spalls per cubic yard set	.268	3,363.19
Transportation from yard to walls per cubic yard set	.309	3,877.70
Laying 12,549.20 cubic yards stone	.816	10,240.14
Cost of Star cement, per cubic yard of stone set	.5705	7,159.32
Cost of Portland cement, per cubic yard of stone set	.1604	2,012.89
Cost of spalls, per cubic yard of stone set	.0539	676.40
Cost of sand, per cubic yard of stone set	.0159	199.53
Total	10.3647	130,068.68

Lock gates.—Work was commenced on the lower lock gates June 1, 1897. The framing of one leaf of the lower lock gate is now finished and clamped up ready for fitting irons. The other gate has thirteen arms dressed and painted, thus completing about three-fourths of the framing of this gate. The lumber for the two upper gates and the iron work for all gates have been received.

Dam excavation.—Removed by dredging and blasting from the bank in front of the abutment 7,335 cubic yards of earth, costing $635.36, or $0.0864 per cubic yard.

All the yellow-pine timber for dam and cribs, amounting to 687,452 feet, B. M., at $16.40 per 1,000 feet, $11,274.21, has been received, and the timber has been transferred from the railway station at Highbridge, Ky., to site of Lock No. 7, at a cost of $286.95, or $0.4174 per 1,000 feet, B. M.

Quarry.—A quarry has been opened on the abutment side and one on the lock side; 959 cubic yards of riprap in all for filling for dam have been quarried, costing $148.25, or $0.154 per cubic yard.

Grading and filling grounds.—Stripped from quarry and wheeled out on grounds for filling holes and inequalities 3,924 cubic yards of earth, costing $864.32, or $0.224 per cubic yard. Handled 1,168 cubic yards of earth for rebuilding roadway, and refilled washout, due to high water at upper entrance to property, at a cost of $415.80, or $0.356 per cubic yard.

The filling behind land wall was commenced and there was stripped from yard and dumped behind wall 2,530 cubic yards of earth, costing $432.62, or 17 cents per cubic yard.

BEATTYVILLE DAM AND ROCK SHOAL QUARRY.

All portable Government property of value was removed, and useless tools and unserviceable property were condemned. There being nothing left at this place but a few buildings, mostly in very bad condition, and a pile of stone of about 4,000 cubic yards rejected as being unserviceable for use in masonry walls, the services of the watchman were dispensed with, to reduce expenses.

Respectfully submitted.

Wm. W. Harts,
First Lieutenant, Corps of Engineers.

Maj. James F. Gregory,
Corps of Engineers, U. S. A.

F F 2.

OPERATING AND KEEPING IN REPAIR THE SIX LOCKS AND DAMS IN KENTUCKY RIVER, KENTUCKY.

The United States acquired possession of the lower five locks and dams (built by the State of Kentucky in 1835–39) in 1880, consequent to the report printed in the Annual Report of the Chief of Engineers for 1879 (pp. 1398–1422). The work accomplished in repairing and rebuilding these five locks and dams is described in the Annual Report of the Chief of Engineers for 1896 (pp. 2292–2293), and the work of maintaining, during the past fiscal year, these five locks and dams, as well as No. 6, which latter was constructed by the United States and opened to navigation in 1891, is described in the report of First Lieut. William W. Harts, herewith.

Allotments for fiscal year ending June 30—

1885	$15,000.00	1893	$40,503.62
1886	24,000.00	1894	73,065.02
1887	35,133.60	1895	46,435.28
1888	82,308.54	1896	59,120.04
1889	82,478.50	1897	70,198.85
1890	72,394.80		
1891	28,889.07	Total	678,354.00
1892	48,826.68		

REPORT OF FIRST LIEUT. WILLIAM W. HARTS, CORPS OF ENGINEERS.

United States Engineer Office,
Highbridge, Ky., June 30, 1897.

Major: I have the honor to submit herewith the following report concerning the operating and care of locks and dams used in the navigation of the Kentucky River during the fiscal year ending June 30, 1897.

During the past year the river was open to navigation for 324 days. It was closed to navigation for 4 days in April on account of high water, 11 days in January and February on account of ice, and 26 days in November and December on account of placing new stone miter sill at Lock No. 2, the cofferdam being flooded almost continuously from November 26 to December 16, 1896.

The river during the past year has been unusually high, and periods of low water have been of short duration. There was a rise of 17.4 feet in July, and in February and March there was an extraordinarily high stage, lasting for several weeks, this flood reaching 46 feet above pool level at site of Lock No. 7.

Three wire-cable ferry lines have been authorized by the Secretary of War to be put across the river just above Carrollton, Ky.

A new transportation line was put in operation during the year—the Cincinnati and Kentucky River Packet Line, G. W. Cole, president; A. B. Massey, secretary and treasurer; steamer *Burnside*.

The main features of the work of repairs and preservation during the year have been as follows: The dam at Lock No. 1 has been in bad condition for some time and leaks were growing worse. This dam was strengthened by thoroughly backing it with riprap and gravel, and all leakage has been nearly stopped thereby. At Lock No. 2 a new stone upper miter sill was substituted for the old wooden sill, leaving Locks Nos. 1 and 5 the only ones that have this upper sill still made of wood. The crib at the abutment that was falling down has been rebuilt but not yet filled with riprap. At Lock No. 3 the old abutment crib work had to be all torn out and replaced. At Lock No. 4 the defective stones in the lock walls were cut out and new pieces set in. The upper land crib has been extended, and the lower river crib was rebuilt entire. At Lock No. 5 leaks in the dam were successfully stopped by backing it with stone.

During the year all locks were kept in good working order, and all Government property cared for; all outbuildings and fences were whitewashed; vegetation destroyed from slope walls, cribs, and walks; lock entrances were kept free from drift and mud, and all lock gates and operating irons were painted.

The following is a detailed statement of the work done:

LOCK NO. 1.

Dam.—The dam has been thoroughly backed with 4,631 cubic yards of riprap and 2,070 cubic yards of gravel, forming an auxiliary dam above the old dam to stop leaks and strengthen it; removed old and defective sheeting and replaced it with new oak sheeting.

Lock.—Repaired defective stones in lock walls by cementing them; placed in position two new signal posts; painted all signal and check posts; repaired steps leading from lock walls to roadway. Due to its dangerous condition, the lower river crib was torn down to the water's edge.

Cisterns.—Two cisterns built for the lock master and lock hand were completed at the following cost:

Materials:		
40 barrels cement, at $1.07	$42.80	
8,000 brick, at $8 per thousand	64 00	
2 tops and covers, at $5.50	11.00	
		$117.80
Labor:		
Brick masonry, 37½ days, at $3 per day	112.50	
Excavation, 167.14 cubic yards, at 35 cents per yard (estimated).	58.50	
		171.00
Total cost of two cisterns		288.80

Coal bin.—A bin for storing coal was built about 200 feet above the lock entrance; a derrick was erected for handling coal, timbers, etc., and a landing dredged for handling barges, flats, etc.

The highest water occurred February 27, 1897, upper gauge reading 39.7 feet. Lowest water occurred September 27, 1896, upper gauge reading 6.7 feet, lower gauge 6.1 feet.

LOCK NO. 2.

Lock.—New stone miter sill: 43.7 cubic yards of stone was cut at site of Lock No. 7, and transported to Lock No. 2, for constructing new stone upper miter sill; a double cofferdam was built in the upper entrance; the old wooden miter sill was torn out and the new stone miter sill was completed at the following cost:

Materials:	
60 cubic yards stone, at $5.50	$330.00
1,470 pounds iron, at $2.35 per cwt	34.54
100 pounds sulphur, at 4½ cents per pound	4.50
940 feet B. M. pine lumber	36.60
6,496 feet B. M. lumber	77.95
26 barrels Portland cement, at $2.67	69.42
2 barrels salt, at $1.65	3.30
5 cubic yards sand, at 25 cents	1.25
	557.56
Labor:	
Pay rolls	1,076.93
Total actual cost	1,634.49
Incidental expense due to high water	331.33
Total cost, not including incidental expenses	1,303.16

Amount of stone laid, 43.07 cubic yards; average actual cost, $37.88 per cubic yard; average cost, not including incidental expense due to high water, $30.19 per cubic yard.

River was closed for navigation from November 25, 1896, to December 20, 1896. The cofferdam was flooded almost continuously from November 26 to December 16, 1896. The actual work required about seven days.

Lower abutment crib.—The lower abutment crib was commenced May 25, 1897, and was completed, with the exception of riprap filling, June 19, 1897. It is 138 feet long, with a return wing to bank 152 feet long; 21 feet 4 inches high; 16 feet wide on the bottom, and 14 feet wide on top.

The following is the cost of its construction:

Cost of lower abutment crib:	
Materials—	
93,701 feet B. M. timber, at $16.50	$1,546.07
6,646 pounds spikes, at $1.95 per cwt	129.59
Paints, oils, etc	9.77
Labor—	
Pay rolls, May and June, 1897	635.61
Total	2,321.04

Average cost of timber laid, without ballast, $24.664 per thousand.

Highest water occurred February 25, 1897, the upper gauge reading 38 feet. Lowest water occurred September 27, 1896, upper gauge reading 7.5 feet, lower gauge 4.7 feet.

LOCK NO. 3.

Dam.—Removed thirty-nine pieces of old and defective sheeting from dam and replaced them with new oak sheeting.

Repaired end of upper land crib; made traveler for signal lights; repaired and painted skiffs; repaired roof of lock house.

Abutment cribs.—The lower and upper abutment cribs were torn down and were rebuilt at the following cost; they are completed with the exception of the riprap filling:

Cost of crib above abutment:	
Materials—	
9,690 feet B. M. timber, at $12 per thousand	$116.28
19,716 feet B. M. timber, at $16.50 per thousand	325.31
Spikes	60.00
	501.59
Labor—	
Pay rolls	625.43
Cost of crib above abutment	1,127.02
Cost of crib below abutment, including two breakwater cribs:	
Materials—	
82,680 feet B. M. timber, at $12 per thousand	992.16
184,131 feet B. M. timber, at $16.50 per thousand	3,038.16
Spikes	283.10
	4,313.42
Labor—	
Pay rolls	1,784.57
Cost of crib below abutment	6,097.99
Summary:	
Cost of upper crib	1,127.02
Cost of lower crib	6,097.99
Total cost of two cribs	7,225.01

Average price of timber laid in upper crib, $38.33 per thousand; average price of timber laid in lower crib, $22.85 per thousand.

Highest water occurred February 28, 1897, the upper gauge reading 39.7 feet. Lowest water occurred November 14, 1896, upper gauge reading 7.3 feet, lower gauge, 6.1 feet.

LOCK NO. 4.

Dam.—Removed fifty-seven pieces of old and defective sheeting from dam and replaced them with new oak sheeting.

Lower river crib.—Removed from lower river crib 180 cubic yards of stone and 50 cubic yards of earth; tore out 4,776 linear feet of old timber and rebuilt crib, using in its construction 84,570 feet B. M. timber; quarried 1,700 cubic yards of riprap and placed in crib as ballast, 1,922 cubic yards being required to fill it. The following are the dimensions of the lower river crib:

Length of crib, 120 feet; width of crib on bottom, 14 feet; on top, 12 feet; height of crib, lower end, 34 feet; upper end, 31 feet; batter of crib, 1 inch to 1 foot, outside, inside plumb.

Extension to upper land crib.—Drove sixty-one piles for foundation of crib, and laid in crib 50,906 feet of timber. The dimensions of the extension to upper land crib are as follows:

Length of crib, 262 feet; width of crib, top and bottom, 12 feet; height of crib, 9 feet 6 inches. These tie cribs were built 32, 24, and 16 feet long, respectively.

The lower river crib and the extension to the upper land crib were completed at the following cost:

Materials:	
135,476 feet B. M. timber, at $16.50	$2,235.35
Spikes	221.10
Paints, oils, etc	132.31
	2,588.76
Labor:	
Pay rolls	3,236.65
Total cost of the two cribs	5,825.41

Summary.—Amount of timber in lower river crib, 84,570 feet B. M.; average cost, $43 per thousand. Amount of timber in extension to upper land crib, 50,906 feet B. M.; average cost, $43 per thousand. This cost includes rock filling and tearing out old structures.

Lock.—The lock walls were repaired by cutting out sixty old defective stones and replacing with new stones, at the following cost:

Labor:	
Pay roll for cutting new stone	$273.09
Pay roll for cutting out defective stones and setting new plugs in position in walls	487.47
Total cost	760.56

Average cost of cutting 7.33 cubic yards of stone, $37.257 per cubic yard. Average cost of cutting out defective stones, cutting new stone and placing same in position, $103.759 per cubic yard.

Highest water occurred February 24, 1897, upper gauge reading 32.2 feet. Lowest water occurred October 31, 1896, upper gauge reading 6.4 feet, lower gauge 5 feet.

LOCK NO. 5.

Dam.—One hundred and twenty-seven pieces of old and defective sheeting were removed from the dam and replaced with new oak sheeting, and the leaks in the dam have been successfully stopped by backing it with 3,024 cubic yards of riprap, at a cost of $3,126.50, or $1.03¼ per cubic yard.

A stone wall that had been washed out by the high water was rebuilt; the wall is 86 feet long, 3 feet wide, and 6 feet high; the roof of the lock house was repaired.

Highest water occurred February 24, 1897, the upper gauge reading 33 feet. Lowest water occurred September 16, 1896, upper gauge reading 8.6 feet, lower gauge 4.3 feet.

LOCK NO. 6.

Pointed 116¼ square yards of slope wall with cement to keep out vegetation; graded and sodded and set out shade trees on bank above slope wall; pointed flagging behind land wall; repaired washouts which occurred on account of high water in slope fill and roadway; replaced two defective pieces of timber in upper land crib.

Highest water occurred February 27, 1897, upper gauge reading 30.5 feet. Lowest water occurred September 26, 1896, upper gauge reading 9.3 feet, lower gauge 3.7 feet.

DUMP SCOWS.

Two dump scows were completed and launched November 14 and 16, 1896. These scows are 70 feet long, 17 feet wide on deck, 15 feet wide on bottom, and have eight side dump pockets each. The scows draw, empty, 22 inches, and each holds 85 cubic yards of dredged material. They were completed at the following cost:

Superintendence		$51.00
Blacksmithing	$170.50	
Carpentry work, painting, etc	2,076.79	
Calking	358.38	
		2,605.67
Lumber, 46,292 feet B. M	1,005.81	
Oakum	82.00	
Hardware, castings, shaft, etc	520.76	
Paint	28.75	
		1,637.32
Total for the two scows		4,293.99

U. S. TOWBOAT GEN. O. M. POE.

The U. S. towboat *Gen. O. M. Poe* was in active service until February 17, 1897, when she went into ordinary at Carrollton, Ky. She was again put into commission May 18, 1897. She has run a total of 6,047 miles, removed 39 snags, and towed 282 barges, dredges, derrick boats, and scows a total distance of 2,697 miles. She has been of utmost service at work at the several locks and dams in towing loaded and empty barges and handling dredges and scows and assisting at various works of repairs. She has assisted in building cofferdam, in removing gates and putting in new stone miter sill at Lock No. 2; loaded timbers on barges at Frankfort, and towed same to Locks Nos. 7, 2, and 3, for new crib work; assisted in removing lower river crib at Lock No 4; and in tearing down and rebuilding guide cribs at Lock No. 1; loaded 846 cubic yards of riprap on barges at Sparke's quarry and towed and unloaded same in cribs at Lock No. 3; loaded 176 cubic yards of riprap at quarry and towed same to Lock No. 4, and unloaded it in the cribs; loaded 346 cubic yards at Sparke's quarry and towed same to Lock No. 2; assisted in general work at Lock No. 7, in pumping out cofferdam, putting up and dismantling derricks, unloading sand, cement, etc.

U. S. DREDGE NO. 1.

The U. S. dredge No. 1 was in active service until February 16, 1897, when she went into ordinary at Frankfort, Ky. She was towed to Louisville, Ky., April 5, 1897, by the U. S. snag boat *Wm. Preston Dixon*, in order to make necessary repairs to her hull and machinery, and was again placed in commission June 29, 1897, when she was towed to Lock No. 7, Kentucky River, June 29, 1897, by the U. S. towboat *Gen. O. M. Poe*. She has dredged 5,335 cubic yards of materials for foundation of dam, 3,910 cubic yards of sand for masonry work, and 280 cubic yards of sand and gravel for repairing cofferdam at Lock No. 7; dredged 2,590 cubic yards of material for foundation of crib below abutment, and 2,710 cubic yards for foundation of crib above abutment at Lock No. 3; dredged 380 cubic yards from lock entrances at Lock No. 3; assisted in the construction of two dump scows and in quarrying 846 cubic yards of riprap at Sparke's quarry for filling cribs; assisted in rebuilding the abutment cribs at Lock No. 3; overhauled and repaired hull and machinery of dredge; watched and cared for dredge and Government plant.

U. S. DREDGE NO. 2.

The U. S. dredge No. 2 was in active service until February 16, 1897, when she went into ordinary at Frankfort, Ky., and was again put into commission April 22, 1897. She has been employed mostly in dredging lock entrances and assisting in rebuilding crib works at the various locks. The following amounts of material have been dredged from the lock entrances and pits:

	Cubic yards.		Cubic yards.
Lock No. 1	1,190	Lock No. 4	1,363
Lock No. 2	1,300	Lock No. 5	3,005
Lock No. 3	2,200	Lock No. 6	4,690

Dredged 1,410 cubic yards of material for foundation of extension of the upper land crib at Lock No. 4, and assisted in building the extension and in rebuilding the lower river crib at Lock No. 4; dredged 925 cubic yards of sand and gravel for foundation of dam at Lock No. 7; assisted in rebuilding triangular pier at Lock No. 1; assisted in building cofferdam at Lock No. 2, and in tearing out old wooden miter sill; removed cofferdam when repairs were completed; assisted in quarrying riprap at Sparke's quarry for crib filling; overhauled and repaired machinery of dredge; watched and cared for dredge and other Government property; assisted in storing Government plant at Lock No. 7.

U. S. DERRICK BOAT NO. 1.

The U. S. derrick boat No. 1 was in active service until February 16, 1897, when she was placed in ordinary at Frankfort, Ky., and was again put into commission May 24, 1897. She removed from cofferdam at Lock No. 7 635 cubic yards of stone and earth, 4,332 cubic yards of deposit made by overflowing of cofferdam, 5,002 cubic yards of earth, and 326 cubic yards of stone; stacked 368,764 feet B. M., of timber; handled stone, timbers, cement, sand, etc., at Lock No. 7; dredged for foundation of abutment cribs at Lock No. 3, and assisted in constructing cribs; removed drift from the entrance at Locks 3 and 4; assisted in building cofferdam at Lock No. 2 and in laying new stone upper miter sill; assisted in quarrying riprap for filling cribs at Sparke's quarry; assisted in building triangular guide pier at Lock No. 1.

U. S. DERRICK BOAT NO. 2.

The U. S. derrick boat No. 2 was in active service until February 16, 1897, when she was placed in ordinary at Frankfort, Ky., and was again put in commission June 1, 1897. She was employed at Lock No. 7, and removed from cofferdam for foundation of lock walls 440 cubic yards of stone and earth, 3,531 cubic yards of deposit, 3,922 cubic yards of earth, and 243 cubic yards of stone; stacked 36,869 feet B. M., of crib timbers; handled sand and cement for masonry work; assisted in tearing out old lower river crib at Lock No. 4 and assisted in rebuilding same; assisted in building extension to upper land crib and filling same with riprap; handled timber and assisted in rebuilding abutment cribs at Lock No. 3 and partly filled same with riprap; assisted in quarrying riprap at Sparke's quarry for filling cribs.

Respectfully submitted,

Wm. W. Harts,
First Lieutenant, Corps of Engineers.

Maj. James F. Gregory,
Corps of Engineers.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, improved by locks and dams during the fiscal year ending June 30, 1897.

Month.	Lock No. 1.				Lock No. 2.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.								
July	$115.00	$44.08	$0.00	$159.08	$115.00	$0.00	$0.00	$115.00
August	165.00	172.34	1.10	338.44	165.00	40.00	1.10	206.10
September	133.33	2,929.68	10.39	3,073.40	133.33	.00	.00	133.33
October	99.34	5,597.15	8.09	5,704.58	115.84	332.30	6.88	455.02
November	185.16	705.05	6.62	896.83	201.66	245.79	22.29	469.74
December	113.34	274.93	.35	388.62	113.34	399.88	3.84	517.06
1897.								
January	140.00	54.01	12.13	206.14	140.00	2,577.09	14.28	2,731.37
February	165.00	.00	1.76	166.76	165.00	30.75	1.76	197.51
March	172.50	9.75	3.24	185.49	172.50	17.25	3.20	192.95
April	147.50	34.03	.00	181.53	147.50	.00	.20	147.70
May	120.00	.00	1.79	121.79	120.00	.00	1.79	121.79
June	180.50	28.07	10.83	219.40	180.50	579.73	2.64	762.87
Total	1,736.67	9,849.09	56.30	11,642.06	1,769.67	4,222.79	57.98	6,050.44

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, etc.—Continued.

Month.	Lock No. 3.				Lock No. 4.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.								
July	$115.00	$3.00	$0.00	$118.00	$115.00	$1.00	$0.00	$116.00
August	165.00	495.61	1.10	661.71	165.00	2,250.69	1.10	2,416.79
September	133.33	52.60	.00	185.93	133.33	173.73	.00	307.06
October	115.83	.00	10.33	126.16	115.83	1,235.80	10.33	1,361.96
November	201.67	355.35	6.61	563.63	198.34	1,277.32	10.12	1,485.78
December	113.33	1,342.64	5.00	1,460.97	63.33	718.20	.00	781.53
1897.								
January	140.00	5,066.63	9.90	5,216.53	90.00	87.47	5.31	182.78
February	165.00	.00	1.77	166.77	155.00	21.45	2.55	179.00
March	172.49	377.05	3.20	552.74	172.49	35.41	3.67	211.57
April	147.50	.00	.00	147.50	147.50	74.82	.00	222.32
May	120.00	45.02	1.78	166.80	86.67	83.17	1.78	171.62
June	180.50	17.11	2.63	200.24	148.83	91.04	2.63	242.50
Total	1,769.65	7,755.01	42.32	9,566.98	1,591.32	6,050.10	37.49	7,678.91

Month.	Lock No. 5.				Lock No. 6.			
	Salaries.	Labor and material.	Current and contingent expenses.	Total.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.								
July	$115.00	$18.00	$0.00	$133.00	$115.00	$5.70	$0.00	$120.70
August	165.00	61.79	1.10	227.89	165.00	60.95	2.20	228.15
September	133.34	1,090.90	.00	1,233.24	133.34	5.55	.00	138.89
October	115.83	148.50	6.88	271.21	100.83	48.15	8.58	157.56
November	201.67	188.21	6.61	396.49	155.00	81.20	8.62	244.82
December	113.33	2.00	.00	115.33	113.33	3.30	.45	117.08
1897.								
January	140.00	1.00	5.31	146.31	140.00	6.75	5.31	152.06
February	165.00	2.70	1.77	169.47	165.00	104.45	1.77	271.22
March	172.51	8.27	3.20	183.98	172.51	20.43	3.20	196.14
April	147.50	.00	.00	147.50	147.50	14.05	.00	161.55
May	120.00	.00	1.78	121.78	120.00	4.15	1.78	125.93
June	180.50	62.37	2.63	245.50	180.50	57.70	2.63	240.83
Total	1,769.68	1,592.74	29.28	3,391.70	1,708.01	412.38	34.54	2,154.93

Month.	U. S. steamer General O. M. Poe.					U. S. dredge No. 1.			
	Salaries and labor.	Repairs.	Subsistence.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Total.
1896.									
July	$902.89	$0.00	$0.00	$0.00	$902.89	$0.00	$0.00	$0.00	$0.00
August	886.83	62.25	691.81	225.30	1,866.19	.00	28.25	.00	28.25
September	878.66	6.00	191.42	55.97	1,132.05	.00	.00	.00	.00
October	872.84	.00	.00	.00	872.84	.00	.00	.00	.00
November	945.71	475.40	534.70	1,229.06	3,184.87	447.50	.00	.00	447.50
December	909.00	50.81	646.79	232.93	1,839.53	436.00	.00	.00	436.00
1897.									
January	864.83	.00	326.57	140.82	1,332.22	492.94	28.84	.00	521.78
February	1,128.24	.00	.00	7.71	1,135.95	526.50	.00	.00	526.50
March	554.32	354.95	284.52	227.61	1,421.40	248.33	.00	5.00	253.33
April	558.66	10.14	69.44	37.55	675.79	132.50	.00	23.68	156.18
May	604.88	.00	108.35	.00	713.23	132.50	9.70	2.20	144.40
June	815.08	253.75	189.09	572.96	1,830.88	221.59	247.59	159.10	628.28
Total	9,921.94	1,213.30	3,042.69	2,729.91	16,907.84	2,637.86	314.38	189.98	3,142.22

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Kentucky River, Kentucky, etc.—Continued.

Month.	U. S. dredge No. 2.				U. S. derrick boat No. 1.			
	Salaries and labor.	Repairs.	Supplies.	Total.	Salaries and labor.	Repairs.	Supplies.	Total.
1896.								
July	$448.00	$0.00	$0.00	$448.00	$0.00	$0.00	$0.00	$0.00
August	436.00	.00	.00	436.00	.00	24.00	.00	24.00
September	440.50	.00	56.02	496.52	.00	.00	.00	.00
October	422.50	.00	.00	422.50	.00	.00	.00	.00
November	904.33	32.62	29.34	966.29	.00	.00	.00	.00
December	467.50	.00	8.65	476.15	.00	1.00	14.97	15.97
1897.								
January	418.00	.00	.00	418.00	67.02	100.04	.00	167.06
February	473.50	.00	.00	473.50	75.00	.00	.00	75.00
March	207.00	.00	127.87	334.87	64.00	.00	.00	64.00
April	132.50	.00	.00	132.50	45.00	.00	.00	45.00
May	279.46	33.20	50.08	362.74	45.00	.00	22.69	67.69
June	460.57	15.00	261.65	737.22	34.50	.00	88.37	122.87
Total	5,089.86	80.82	533.61	5,704.29	330.52	125.04	126.03	581.59

Months.	U. S. derrick boat No. 2.			
	Salaries and labor.	Repairs.	Supplies.	Total.
1896.				
July	$0.00	$0.00	$0.00	$0.00
August	.00	.00	.00	.00
September	.00	.00	.00	.00
October	.00	.00	.00	.00
November	.00	.00	.00	.00
December	.00	.00	.00	.00
1897.				
January	.00	.00	.00	.00
February	142.50	.00	.00	142.50
March	64.00	9.00	8.76	81.76
April	45.00	.00	.00	45.00
May	45.00	.00	8.15	53.15
June	45.00	.00	24.68	69.67
Total	341.50	9.00	41.58	392.08

Constructing dump scows	$4,293.00
Watching Government property, Beattyville, Ky	45.00

SUMMARY.

Kentucky River:		U. S. dredge No. 1	$3,142.22
Lock No. 1	$11,642.06	U. S. dredge No. 2	5,704.29
Lock No. 2	6,050.44	U. S. derrick boat No. 1	581.59
Lock No. 3	9,566.98	U. S. derrick boat No. 2	392.08
Lock No. 4	7,678.91	Constructing dump scows	4,293.99
Lock No. 5	3,391.70	Watching, Beattyville, Ky	45.00
Lock No. 6	2,154.93		
U. S. steamer *Gen. O. M. Poe*	16,907.84	Total	71,552.03

Kentucky River, Kentucky, leases for year ending June 30, 1897.

Location.	Lessee.	Dated.	Expires.
Lock No. 4	Kentucky River Mills	July 10, 1878	July 10, 1977.

The lease was made by the Commonwealth of Kentucky.

Collections for Kentucky River, Kentucky, for year ending June 30, 1897.

Lessee.	Subject.	Amount collected.
Kentucky River Mills	Land and water power	$180

Commercial statistics of Kentucky River, Kentucky, for fiscal years ending June 30, 1890–1897 (improved and unimproved portions).

Articles.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Beer			345	325	193	52	38	50
Brick			130	771	1,394	156	87	139
Coal	89,562	89,752	203,224	177,083	108,169	49,912	34,811	28,439
Cement			200	1,116	1,919	333	418	1,445
Cooperage			736	889	670			
Cross-ties			1,445	725				
Grain	6,991	14,279	10,219	12,094	7,859	4,344	3,142	2,727
Flour	1,503	1,744	6,233	5,120	6,407	1,719	1,678	1,473
Hay	4,407	500	6,488	5,671	2,273	2,620	2,183	989
Iron	1,903	712	4,292	493	175			
Live stock	2,350	3,065	2,506	2,071	2,288	838	1,217	1,047
Lime							450	453
Logs	158,903	224,844	72,749	63,197	68,866	206,342	198,514	256,658
Lumber	10,670	15,256	13,336	13,084		3,170	1,667	1,683
Merchandise, miscellaneous	19,554	21,739	60,618	28,156	25,744	13,810	9,799	9,433
Salt	909	1,602	9,025	4,276	3,328	654	1,129	978
Timber	4,682	3,761	21,831	3,131	3,078		3,000	1,000
Tobacco	2,783	5,636	11,199	5,808	11,667	4,468	4,638	5,315
Whisky	4,142	4,306	4,098	3,263	3,732	5,059	4,533	3,927
Passengers	1,995	2,023	3,172	3,176	3,055	2,841	2,082	1,976
Total	310,354	389,219	431,846	330,449	250,817	296,318	269,386	317,727

List of stern-wheel boats plying on the Kentucky River, Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Gen. O. M. Poe	U. S. towboat	127	30	5	300
Wm. Preston Dixon	U. S. snag boat	124.9	32	5	200
P. D. Stagg	Packet	161	28.6	4.4	282.14
John Barrett	do	124.8	31	5.3	187.23
Rescue	do	121	28	4	139.03
Burnsides	do	136	21	4.6	92.11
Huston Combs	do	98	22	3.4	95.96
Little Sandy	do	94	16	3	39.34
F. J. O'Connell	do	92.6	18.1	3.4	57.62
C. O	do	81	15.7	2.7	19.44
Eureka	do	56	13.8	2.5	45.60
Annett	do	93	21	3.6	92.11
Ghent *a*	do	53	10	4	4.85
Jim Montgomery	do	60	18	2.6	28.85
Kalista	do	47.9	9.3	3.9	9.08
Tom Ross	do	33	6.6	3.6	9.72
Shawnee	do	35	10	3	6.65
Champion No. 2	do	76	23.8	3.4	52.16
Al Martin	Towboat	112	23.6	4	96.68
Andy	do	85	11	7	45.40
Troubadour	do	97	18	3	61.37
Sawyer	Saw boat	116	18	4.2	70.00
D. D. Baker	do	117	18.3	4.3	70.83
Rover	do	100	18	3.6	65.00
Dixie *a*	Pleasure boat	45	8.6	4	3.72
Emily	do	25	6	2.6	1.50
Old Elk	do	51	10	3	4
Gunther	do	30	7	3.5	4.50
Saratoga	do	23	6	2	3.70
Ramonia	do	(*b*)	(*b*)	(*b*)	(*b*)
Juanita	do	(*b*)	(*b*)	(*b*)	(*b*)

a Screw propeller. *b* Unknown.

Reports of lockage on Kentucky River, Kentucky, for the fiscal year ending June 30, 1897.

Locks.	Days operated.	Days suspended.	Going up.			Going down.				Total crafts and flats passing.	Total number lockages.
			Steamboats.	Barges and flats.	Miscellaneous.	Steamboats.	Barges and flats.	Rafts.	Miscellaneous.		
No. 1	351	14	377	104	55	369	102	199	53	1,259	825
No. 2	329	36	326	106	31	325	106	184	46	1,124	948
No. 3	352	13	216	72	77	221	74	114	82	856	762
No. 4	350	15	240	110	98	230	111	157	131	1,077	887
No. 5	355	10	163	38	66	161	50	1,010	77	1,565	1,114
No. 6	344	21	157	23	105	150	30	1,083	114	1,662	962
Total	......	......	1,479	453	432	1,456	473	2,747	503	7,543	5,498

F F 3.

IMPROVEMENT OF TUG FORK OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The project for the improvement of this stream, adopted in 1880, provides for removing snags, rocks, overhanging trees, and forming low wing dams of loose stones at shoal places to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push boat and raft navigation. The characteristics of the stream are described in the following-named annual reports of the Chief of Engineers: 1875, pages 756–769; 1889, pages 1990–1994, and 1886, page 2323.

For details of the work done during the past fiscal year attention is invited to the report of Mr. B. F. Thomas, assistant engineer, herewith.

Money statement.

July 1, 1896, balance unexpended	$2,094.78
June 30, 1897, amount expended during fiscal year	1,356.03
July 1, 1897, balance unexpended	738.75
Amount that can be profitably expended in fiscal year ending June 30, 1899	1,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1877 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

June 14, 1880	$2,500	July 13, 1892	$2,500
March 3, 1881	2,000	August 18, 1894	2,500
August 2, 1882	5,000	June 3, 1896	2,000
July 5, 1884	5,000		
August 5, 1886	3,750	Total	27,750
September 19, 1890	2,500		

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to forward herewith my report upon the improvement of the Tug Fork of Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1897.

The improvements were in charge of Fred McHenry. A crew was started out from the mouth at Louisa in August and closed the work on October 30. The river was well cleaned and repaired to Lick Shoal, about 64 miles above Louisa, work being done at Lick Shoal, Lawsons, mouth of Pond Creek, Williamson, Turkey Shoal, Sugar Tree Falls, Buffalo Shoal, Alley Island, Big Creek Shoal, Mount Sterling Shoal, Pigeon Shoal, Long Branch, Marrowbone Creek, Jennies Creek Shoal, Silver Creek, Crums Milldam, Calf Creek, Whitt Bar, and Lost Creek. The river was placed in the finest condition it has ever been, and, outside of ordinary repairs, caused by the formation of new snags and the effect of ice on the walls and wing dams, it will require but little attention.

The construction of the Norfolk and Western Railroad along the river from the mouth of Pigeon to the head renders the river of much less importance for steamboat navigation than formerly, as the railroad carries the bulk of freight. Below Pigeon the river is still the only means of transportation for a distance of 40 miles, and it should be kept in good navigable condition.

For the transportation of timber rafts the whole length of the river is as much used as ever. With an annual appropriation of $1,000 or $1,500 the river can be kept in splendid condition for its traffic.

A summary of the work done shows 68 snags, 12 trees, 50 stumps, 998 cubic yards solid rock, and 4,220 cubic yards loose rock removed.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

F F 4.

IMPROVEMENT OF LEVISA FORK OF BIG SANDY RIVER, KENTUCKY.

The project for the improvement of this stream, adopted in 1880, provides for removing snags, rocks, overhanging trees, and forming low wing dams of loose stones at shoal places, to concentrate and deepen the water at those places, so as to aid light-draft steamboat, push-boat, and raft navigation. The characteristics of the stream are described in the following-named Annual Reports of the Chief of Engineers: 1875, pages 756–769; 1876, pages 140–146; 1884, pages 1755–1756; 1887, page 1902; 1888, pages 1795–1798; 1889, pages 1990–1994, and 1896, pages 2320–2321.

For details of the work done during the past fiscal year attention is invited to the report of Mr. B. F. Thomas, assistant engineer, herewith.

In the Annual Report of the Chief of Engineers for 1896 (p. 2321), the necessity for the construction of a dike, to cost about $10,000, was mentioned; its necessity was more fully explained on page 2322 of the same report. The necessity for the construction of the dike has increased during the past season, one steamboat and many rafts having been destroyed at that point during the last year.

Money statement.

July 1, 1896, balance unexpended	$1,107.12
June 30, 1897, amount expended during fiscal year	1,013.05
July 1, 1897, balance unexpended	94.07
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	11,500.00

APPROPRIATIONS.

June 14, 1880	$2,500
March 3, 1881	2,000
August 2, 1882	5,000
July 5, 1885	5,000
August 5, 1886	3,750
September 19, 1890	2,500
July 13, 1892	$2,500
August 18, 1894	2,500
June 3, 1896	1,000
Total	26,750

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to submit herewith the following report concerning the improvement of Levisa Fork of Big Sandy River, during the fiscal year ending June 30, 1897:

The work was in charge of Mr. J. C. Butler, master of the steamer *Fairplay*, and consisted of the removal of snags, trees, and other obstructions in the channel, and the cleaning of shoals, cutting of overhanging trees, and repair of wing dams and walls.

The amount of money available was not sufficient to enter upon any new work of improvement, although several places could be greatly benefited, and the work done was in the nature of maintenance rather than construction or improvement. The work was commenced toward the last of August and closed in the last of October, this being usually the best low-water season. It extended from Louisa to Huffman's warehouse, 2 miles above Pikeville, a total distance of nearly 90 miles. Work was done at Pikeville, Long Shoal, Grimes Shoal, Mouth of Big Mud, Laynes Dam, Prater Shoal, Mouth of Beaver, Sugar Loaf Shoal, Prestonburg, Middle Creek, Wireman Shoal, Johns Creek, Hells Gate, Paint Shoal, Buffalo Shoal, Greasy Shoal, Ward City, Red House Bend, White House Shoal, Chestnut Swirl, Richardson, Georges Creek, Torchlight, Dock Millers, Miller Bend, and Three Mile.

In addition to cleaning the shoals and repairing the walls and wing dams at the foregoing points, 123 snags, 113 trees, and 48 stumps were removed from the channel, and 7 trees were topped. The quantity of solid rock blasted out was 357 cubic yards. In cleaning the shoals and other work of like character 5,126 cubic yards of loose rock was taken out, about $900 being expended.

In my last annual report, and also in a letter of May 1, 1896, I recommended the expenditure of about $10,000 at Georges Creek. This place has gotten much worse since that report, and the steamer *Favorite* was wrecked there during the past winter, and numbers of rafts were torn up. Unless something is done at that point soon it is probable that it will become the head of steamboat navigation, although there are 75 miles of navigable river above it.

The recommendation made in my last annual report that $10,000 be expended there is renewed. The recommendation that surveys be made at Middle Creek and Buffalo Shoal to determine the nature and cost of works required to secure good navigation, which was made in my report of 1896 is also renewed. These three points, Georges Creek, Buffalo, and Middle Creek, should all be improved without delay, as many of the improvements along the river are rendered practically valueless at certain seasons because these points can not be passed.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

F F 5.

IMPROVEMENT OF BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.

The original project for the improvement of this stream, from its formation by the junction of Levisa and Tug forks, at Louisa, Ky., down to its mouth in the Ohio, at Catlettsburg, Ky., a distance of 26 miles provided for open river navigation. This project was adopted in 1878. In 1880 the project was modified so as to provide for the construction of a test lock, with a fixed dam, below the junction of the two forks. In 1891 the project was changed so as to provide for the construction of a movable dam instead of the fixed dam.

The projects of 1878 and 1880 were adopted consequent to the report printed in the Annual Report of the Chief of Engineers for 1875 (pp. 756–769).

Up to the close of the last fiscal year the lock at Louisa had been completed, ready to receive the gates and their operating machinery, and the masonry work of the dam, center pier, navigation pass, and weir had been completed, ready to receive the trestles and wooden needles.

During the past fiscal year the lock gates were constructed, put in place, and the operating machinery purchased and placed, and the movable ironwork for the entire dam was purchased of John P. McGuire, under contract dated August 12, 1896, and put in place. After some difficulty in obtaining the wooden needles of the required quality of soundness, general perfection, and manufacture they were finally purchased, after overhauling the timber in a large lumber yard in Chicago. The lock and dam were opened to navigation January 1, 1897.

Under date of February 11, 1896, I submitted a recommendation providing for certain changes in the approved plans of the dam (Annual Report, Chief of Engineers, 1896, p. 2302). The report of the Board of Engineer Officers convened to report on the proposed changes is printed in the Annual Report of the Chief of Engineers for 1896 (pp. 2302–2318), and under date of May 15, 1896, the Chief of Engineers authorized the use of sizes of iron then manufactured and the change in form of trestles of navigable pass, so that when lying down the trestles would lie flat within the other. The question of raising the sill of the navigable pass 12 inches was directed to be delayed until it had been tried at its then present height, and the use of needles for the weir of the dam was deemed advisable, instead of wickets of the form used on the weir of the dams in the Great Kanawha River, as recommended by me.

Under date of January 27, 1897, I submitted a project for the construction of a boom, about 800 feet long, to be located above the lock, with which to control and hold drift coming down the stream in times of rises, until the dam could be lowered; this was approved March 24, 1897. The boom has been constructed and put in use.

The characteristics of this stream are described in the following-named Annual Reports of the Chief of Engineers: 1875, pages 756–769; 1876, pages 140–146; 1884, pages 1755–1756; 1887, page 1902; 1889, pages 1990–1994; 1896, pages 2300–2302, and the various causes which led to the construction of a needle dam instead of a fixed dam, or wicket dam, are explained in the Annual Report of the Chief of Engineers for 1892, pages 2101–2108.

For details of the work done during the past season, attention is invited to the report of Mr. B. F. Thomas, assistant engineer, herewith, marked A.

Mr. Thomas has prepared also a detailed description of the lock and needle dam, a history of its construction, statements of cost, and an explanation of the methods employed to operate it; this report is marked B. Mr. D. A. Watt, civil engineer, of my office, submits a report illustrating the calculations made by him for the trestles and the needles of the dam; this report is marked C.

As the cost of this lock and dam was materially increased by the change of project from a fixed dam to a needle dam, and as the appropriations have been comparatively small in amount, and have extended through the period of over fifteen years, Mr. Thomas has prepared, by my direction, an estimate of what it would cost to build a lock and needle dam, similar to the one completed during the past year in the Big Sandy, assuming that it would be free of expensive changes during the course of construction, etc. This report is marked D. Three tracings of the drawings of the lock and the needle dam and twelve photographs of this lock and movable dam, taken on December 29, 1896, and on January 2 and 12, 1897, are also forwarded herewith.

Money statement.

July 1, 1896, balance unexpended	$38,541.95
June 30, 1897, amount expended during fiscal year	32,205.58
July 1, 1897, balance unexpended	6,336.37
July 1, 1897, outstanding liabilities	598.61
July 1, 1897, balance available	5,737.76
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	2,000.00

APPROPRIATIONS.

July 18, 1878	$12,000	August 11, 1888	$31,500
March 3, 1879	12,000	September 19, 1890	31,000
June 14, 1880	50,000	July 13, 1892	50,000
March 3, 1881	46,000	August 18, 1894	40,000
August 2, 1882	15,000	June 3, 1896	30,000
July 5, 1884	40,000		
August 5, 1886	22,500	Total	380,000

Abstract of proposals received and opened July 1, 1896, for furnishing and delivering about 31 steel trestles for improving Big Sandy River, West Virginia and Kentucky.

No.	Name and address of bidder.	31 steel trestles, 35,250 pounds (per pound).	Total.
		Cents.	
1	John P. McGuire, Cleveland, Ohio	$4\frac{32}{47}$	$1,650.00
2	Penn Bridge Company, Beaver Falls, Pa	$4\frac{3}{4}$	1,674.38
3	Riter & Conley, Pittsburg, Pa	6	2,115.00
4	Geo. Kinsey & Co., Cincinnati, Ohio	$10\frac{1}{2}$	3,701.25

Contract awarded John P. McGuire, Cleveland, Ohio.

Abstract of contract for improving Big Sandy River, West Virginia and Kentucky, in force during the fiscal year ending June 30, 1897.

Contractor.	Nature of contract.	Date.	To expire.
John P. McGuire	Furnishing steel trestles	Aug. 12, 1896	[a] Oct. 1, 1896

[a] Extended to November 30, 1896; completed October 31, 1896.

A.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to report upon the work done on Big Sandy River, West Virginia and Kentucky, for the fiscal year ending June 30, 1897.

Buildings.—The large lock house and the addition to office, which had been inclosed the previous year, were plastered and completed ready for occupancy, and the necessary outbuildings and cisterns were constructed, as was also a combined tool house and blacksmith shop. The old buildings on the lock side of river were all removed.

Grounds.—The grounds about the buildings were cleaned of spall rock, which had accumulated during the cutting of stone, and graded; the bank in front, down to paving, was sodded, and the yards sown in grass; walks of broken stone were built along the front and rear of the yards, and a driveway of the same material was constructed across the property to the coal house and shop; thrifty shade trees were planted along the front walk and roadway and along the property lines; the cellars and grounds were drained by vitrified tile leading to river above and below lock.

Protection works.—A retaining wall was built on ledge above and below land wall of lock, the old crib being removed for the purpose. The wall above lock is 379 feet long and varies in height from 12 inches to 8 feet, and that below lock is 233 feet long and about 4 feet in height. These walls form the toe against which the riprap and paving of banks rest. The walls are of roughly cut pitch-face stone laid in cement. Below the bottom of walls the ledge is smoothed up for a safe passage of boats. The paving behind lock was extended upstream 46 feet above lock. The steps leading from lock to top of bank were extended from top of paving to walk along front of grounds. In cleaning the grounds the stone was used for riprapping the bank near lower end of property.

Lock.—New gates were framed and placed in lock, the irons being taken from old gates and used as far as practicable. The old upper gates had been previously removed, but the lower ones were taken out during this year. It was necessary to overhaul all the irons and recut the threads on the bolts, as well as make many additional irons. Iron hollow quoins were placed at upper gates where the wall has been cut down after the change of plan of dam made it necessary to lower upper miter wall.

The wicket shafts for discharging valves were cut off to suit new height of walls, and new screens were placed over wicket openings, and new gratings over wicket crabs. Capstans for holding wickets in any desired position were put on and a wicket which had burst was replaced; ladders were placed on lock walls; shutters for a temporary dam were framed and irons provided for same, and the foundation and sills gotten ready, but owing to high water they have not been put in; iron pins for holding boats in lock were placed, and the capstans for operating gates and rollers upon which rack bars travel were reset; the damaged quoins in lower gate coping were replaced with new stones, and the whole coping of both walls was pointed with Portland cement.

Dam.—Sills upon which to place the trestles were bolted to pass masonry, and the journal boxes for trestles were placed in pass after the same had been coffered off and pumped out. Great difficulty was encountered in maintaining a cofferdam because of the continued high stage of water and freshets. The lower journal boxes for weir trestles were also placed. The trestles were all put in and their connections made with masonry of lock, pier, and abutment; gratings covering trestle recesses were placed on the pier and abutment; crabs for operating trestles were placed on pier and lock wall; the guides which hold the chain on wheel of trestle were all reshaped to prevent catching of chain; the guides on crabs were also altered. A boat for storing needles, and for use in placing and removing them, was built, and also a rudder boom for protecting trestles from drift when dam is being lowered. The needles were framed and ironed on the works.

Miscellaneous work.—A variety of general work was done during the past year, among which may be mentioned the protection of the bank above abutment against leak by driving sheet piles and filling in with rammed clay, and below abutment by washing out sand and replacing with broken stone. The upper entrance to lock filled with drift last summer and 300 pieces, consisting of crossties, logs, trees, etc., were removed. A culvert 65 feet long was built under embankment near lower end of property on West Virginia side of river to carry off water from a farm drain which comes in at this point. The old boiler walls were torn down and the brick cleaned and used in the construction of buildings, etc. The chutes above and below lock were cleaned of all rock and obstructions.

Work remaining to be done.—There is but little work remaining to be done at this lock. There is the completion of the grading of the ground on both sides of the river, the smoothing up of part of the ledge below lock, and extension of retaining wall on same, the placing of shutters for temporary dam in lock and the framing of needles for the other temporary dam in lock, the construction of another lock hand's dwelling, the sodding of banks above riprap and seeding the grounds, the building of fences around the property, the removal of old buildings and machinery, etc., and a few small matters to attend to which will cost but little money.

Operation of lock and dam.—The dam was completely raised for the first time on January 1, 1897, and the first lockage was made the next day; the trestles had been raised and lowered a number of times previous to that. The whole dam has been put up several times without special difficulty, and is operated with great facility and ease, but it is too early yet to determine its value to navigation.

River below Louisa, Ky.—There has been nothing done toward the removal of obstructions in the channel between Louisa and the Ohio for several years, and many dangerous snags have formed, which are a constant menace to navigation. The most troublesome of these are at Savage Branch, 5 miles from the mouth of the river, but there are many others in numerous places in the river. It is estimated that this part of the river can be placed in safe condition for $2,000.

Additional locks and dams.—In his annual report for 1889, Maj. D. W. Lockwood, Corps of Engineers, recommended the appropriation of $100,000 for the commencement of a lock and dam in the Levisa Fork. Subsequent to this, and before action had been taken on this recommendation, the plan of dam at Louisa was changed, the changes requiring considerable additional money, and the subject of another dam was dropped. Now that the original project has been completed and has so far proven successful, the question of additional locks and dams again comes up. The opinions expressed by Major Lockwood that it would be better to first build those locks reaching the coal field are well founded, I think.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

Maneuvers of dam at Louisa, Ky., on Big Sandy River, West Virginia and Kentucky, for fiscal year ending June 30, 1897.

Maneuver.	Date.	Time required.	Remarks.
		Hours.	
Raised	Dec. 31	8	Needles placed from push boat with difficulty.
Lowered	Jan. 5	3	No trouble.
Raised	Jan. 9	5	Without difficulty.
Lowered	Jan. 13	3	Do.
Raised	May 12	10	Heavy deposit on trestles; broke chain twice on recess trestles.
Lowered	May 13	3	No trouble.
Raised	May 25	6	Very easy with five men.
Lowered	June 20	5	Heavy drift and river rising rapidly. Boom warded off all but rails, brush, and chunks.
Raised	June 30	10½	12-inch deposit on sill and trestles; broke chain twice; raised trestles very slowly and placed needles as fast as raised, in order to scour out sand; needles went in without trouble.

B.

DESCRIPTION OF LOCK AND MOVABLE DAM IN BIG SANDY RIVER, NEAR LOUISA, KY.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to transmit herewith, as a part of my annual report, a description of the lock and movable dam in the Big Sandy River at this place, completed during the past year. Owing to the system of small appropriations under which this work has been carried on during a long period of years and the fact that the original project for the construction of a lock and fixed type of dam was changed, after the lock for fixed dam had been completed and the fixed dam partially built, so as to provide for the construction of a lock and movable dam, the annual reports do not well describe the works, the means utilized in building them, and the reasons which lead to their construction as they now stand. The following description has been arranged under the following headings:

I. General description.
II. Construction.
III. Miscellaneous.
IV. Detailed statements of cost.
V. Maneuvering the Needle Dam.

I. GENERAL DESCRIPTION OF THE VARIOUS PARTS OF THE COMPLETED WORK, WITH CAUSES LEADING TO THEIR ADOPTION.

GENERAL DESCRIPTION.

Location.—The lock and needle dam which have recently been completed and put into operation on the Big Sandy River, near Louisa, Ky., are situated just below the junction of the Levisa and Tug rivers, which, uniting at this point, form the Big

Sandy, which empties into the Ohio 26 miles north of the junction. The Levisa is navigable by steamboats during a good part of the year for a distance of 100 miles and the Tug for 60 miles. Beyond these points (and all along these streams during low water) pushboat navigation is usually carried on, so that it may be said that there is generally a means of transportation for local freights throughout the year, except in periods of extreme low water, which are usually of short duration.

Character of river.—These two streams, with their various tributaries, traverse a mountainous territory the soil of which is generally impregnated with sand, which conditions are favorable to frequent and sudden freshets carrying large quantities of sediment and débris, which often become a source of trouble and danger to navigation, particularly on the Big Sandy itself, where the back water from the Ohio reduces the velocity of the current and causes the formation of sand bars and snags. The steep slope and porous nature of the soil are unfavorable to the retention of water for the dry season, and the low-water discharge becomes quite small. The system of regulation and maintenance by which these streams are made navigable for a portion of the time is insufficient for the increasing demands of commerce, and it is only by canalization that they can be rendered even fairly satisfactory, and, even then, evaporation and leakage may partially defeat the objects in view.

Character of commerce to be accommodated.—The greater portion of the present commerce is timber, either in rafts, crossties, staves, or spokes. There is a large undeveloped coal field, which, it is expected, will greatly increase the river trade; and the principal object of the improvement instituted by the construction of this dam is for the transportation of this coal out into the Ohio where it can find a market. In determining the character of dam to be built it was necessary to consider the present and prospective demands of this commerce. To construct a stationary dam would make it imperative for everything to pass through the lock. This would be most injurious to the timber interests. There are times when rafting tides are unfrequent and hundreds of rafts are awaiting sufficient water to reach the Ohio. Even when the long-delayed rise comes it may be of short duration. In such cases a delay of a few days at the lock might mean the failure to reach the markets along the Ohio and Mississippi during a whole season. The same argument applies to the transportation of coal in barges. The formation of a pool will give ample depth of water in which to load the coal as fast as mined and a safe harbor for holding the barges. It is then ready to go out to the Ohio whenever there is the necessary depth below the dam. There are many summer rises wherein this depth only lasts a short time, and should it be necessary to pass the barges through the lock, the delay in so doing might sometimes prevent their shipment, as well as retard rafts awaiting lockage. Another difficulty to be overcome was the accumulation of sand in the quiet water of the pool. Should bars form at points where the depth of water was already barely sufficient for the requirements of navigation, the improvement would be worse than useless. The great amount of drift afloat on every rise also rendered it probable that snags would readily settle in the pool and endanger the safety of navigation.

Original plan of improvement.—The original project for the construction of the lock and dam near Louisa provided for a masonry lock with fixed dam made of timber cribs filled with stone, such as are built on many of our small rivers. The project and the causes leading to its adoption are thus given by Maj. William E. Merrill, Corps of Engineers (Report of the Chief of Engineers, 1879, p. 1354):

"A great deal of good to the rafting interests can be done by a continuance of the present method of improvement, but no radical improvement is possible without the construction of locks and dams. The large deposits of excellent coal on this river will undoubtedly at some day lead to the establishment of a system of slackwater in order to bring it to market. The amount of shifting sand that continually flows down the Big Sandy indicates beyond all doubt that the only way to secure a permanent improvement is by the construction of movable dams, commencing at the mouth and extending upwards to points where the moving sands have become manageable. If permanent dams are built in the lower river the sand deposits will ultimately reduce the depths available for navigation, but with a succession of such dams there will be such a reduction of slope in the pools as will, in spite of the sands, maintain in the channel a greater depth than is now found in the natural river during the season of low water. In other words, permanent dams will notably improve navigation when first built, and this improvement will gradually diminish, but the ultimate depth for navigation will always be greater than it is now, and to this extent the improvement will be permanent. If movable dams are built, all danger from deposits of sand is removed, because the river will be as free during all stages of over 6 feet as it is now, and the sands will be washed downstream just as they are now. The only objection to the immediate construction of movable dams is that they are much more costly per foot lift than fixed dams. The greatest lift from pool to pool at present practicable with a movable dam is 6 feet, while 10 or even 12 feet is not excessive with a fixed dam. The method which I would recommend, in view of all the circumstances connected with this river, is to build a series of fixed timber dams with masonry locks, with a view of ultimately turning the fixed dams into movable ones. To accomplish this I would take 12 feet as the lift of each fixed dam. This would make it necessary when these dams were made movable to interpolate a new movable dam between each pair of transformed dams. If this system were carried out, when it became necessary to make the changes we would only lose the cost of the timber dams, as the masonry locks would be used in connection with the movable dams. The total cost of the system would be only slightly increased, and we would have the advantage of the immediate use of the cheaper system, and the additional advantage of testing by actual experience whether or not fixed dams would answer, or which of them would answer and which would not. The special commerce of the Big Sandy that now needs assistance is coal mining, an interest that fully deserves national aid, as the whole country along the Ohio and Mississippi is interested in having cheap and reliable supplies of coal. The present greatest drawback to coal mining on the Big Sandy is the lack of any pool of deep water in which loaded barges can be stored during low water. The first work, therefore, that should be undertaken is the creation of a pool that will be a benefit to the mining interests, and to as many others as can be accommodated. It is evident that the proper place for this dam is just below the junction of the two forks of the Big Sandy and in the vicinity of the town of Louisa."

Work under this project was begun in 1883 and carried forward at intervals under various small appropriations for several seasons, resulting in the completion of the lock, abutment, and part of the fixed dam, when, in 1891, for reasons which have been given in previous reports, the project for a fixed dam was abandoned and that for a movable dam substituted. (Report of Chief of Engineers, 1892, p. 2102.)

Modified plan of improvement.—It was these special and difficult conditions which in the first place caused the project for a stationary dam to be abandoned, and, in the second place, led to the modifications in the plans of the movable dam after considerable progress had been made on its construction. The result is that the works as finally completed do not present that unity of appearance which should be expected of a structure built on original plans, and the cost has been greatly increased by the numerous alterations and delays.

The plan of improvement as finally agreed upon was a lock of the ordinary pattern and a movable dam with navigable pass having 13 feet on its sill and weir having 7 feet, both closed by needles supported against trestles.

Choice of a system of movable dam.—In choosing a system of movable dam which would most nearly satisfy all the conditions found upon this river, a study was made of existing works of like character in this country and abroad. The navigable rivers of France, with a single exception, the Rhone, are improved with movable dams, several systems being in use. The needle dam of Poiree and the wicket of Chanoine are the two principal types, however, but the Desfontaines drum wicket, the Girard hydraulic shutter, the Boule gate, and the Camere curtain are all in use, as is also a type known as the overhead bridge dam, in which all the supports are pulled up to a bridge spanning the stream when not in use. In this form of dam curtains are used for holding back the water, although other means of closing may be used.

In Belgium the needle dam is in favor, and has been greatly improved over those in France; in Russia quite an extended application of the Boule gate has been made, and needle dams are also much liked; in Prussia the overhead bridge dam, with gates instead of curtains for closing, has been applied; in Germany there are some drum wickets of great size in use; in the United States there was but one type, the Chanoine wicket, either in the original form or as modified by M. Pasqueau at the LaMulatiere dam in France. The bear-trap, the pioneer movable dam, and an American invention, has been neglected so long or tried under such unfavorable conditions that it was scarcely mentioned in the discussion of movable dams a few years ago, although it is capable, at least with a little assistance from another type, of being made successful on streams as small as the Big Sandy, and probably for those of much greater width. In addition to the types mentioned several other forms have been designed and suggested. Some of these have elements of promise, but as they have had no practical application they were not seriously considered in the study. In deciding between the systems proposed or in use the following points are to be considered for a dam at this point:

(1) The unprecedented lift sustained (except on bridge dams).
(2) The sudden high and unexpected rises in the stream.
(3) The great amount of drift carried.
(4) The unusual quantity of sediment traveling.
(5) The great difference in level between high and low water.
(6) The small low-water discharge.

The high lift was considered unfavorable to the use of needles; the sudden freshets, to any form requiring much time for maneuvers, like the Boule gates or Camere curtains with trestles; the drift and sediment, to any system having trestles; the height of high water and the banks, to bridge dams, and the small discharge of the river, to wicket dams of the Chanoine type.

Bridge dams and gates and curtains being considered impracticable for this location, at least as constructed abroad, and the bear traps not being looked upon with favor for a river where any dam is considered more or less an experiment, the choice was narrowed down to the Chanoine wicket or Poiree needle, and it was finally decided to build a needle dam sustaining a considerably greater head than that which had been attained in the high needle dams on the Belgian Meuse or elsewhere, so far as known. •

Composition of works.—With the foregoing general remarks upon the location, conditions, plans, and projects I will now proceed to a more complete description of the details of the various parts of the works, methods of construction, cost, etc.

The works as constructed comprise the following:

(1) A lock in the right or West Virginia bank 52 feet wide, 255 feet long over all.

(2) A navigation pass next the lock 130 feet long.

(3) A weir 140 feet long, separated from the navigation pass by a pier 12 feet wide and terminating in an abutment 17 feet 6 inches wide in the left or Kentucky bank.

The total length of foundation masonry, including the width of lock chamber and walls and omitting wing walls, is about 400 feet, or about the original width of the river at the level of the top of the lock walls.

Stone.—The stone used for the whole work was furnished by contract from the best quality of sandstone to be found in this locality. A statement of the quantities of each class, with cost, is given below:

Stone.	Cubic yards.	Price.	Total.
Special	758.42	$14.25	$11,104.23
Dressed face	1,552.46	7.50	11,643.45
Pitch face	803.42	6.50	5,222.23
Squared	2,002.66	5.50	11,014.66
Backing	2,932.68	5.00	14,663.40
Do	3,136.81	4.00	12,547.25
Total	11,186.52	....	66,285.22

DESCRIPTION IN DETAIL.

LOCK.

Fixing the dimensions.—Aside from the cost, the principal considerations in determining the dimensions of a lock should be the size of the craft and the character and amount of commerce to be passed through it. While the width of this lock was evidently determined in accordance with this view, it is not so clear by what means the length was adopted, as the lock is too short for two barges end to end and too long for one, and is also too short for a boat with barge ahead and for the longest rafts as usually made on this river. A lock with an available length of 255 feet would answer the purpose much more completely than does this, as this would admit a towboat with two barges ahead and one alongside. The width of the lock is ample for two 25-feet barges side by side, and, with the length as suggested, a boat with three barges, or two rafts, or four barges could be passed at one lockage. However, with a movable dam there is not so much need of a large lock, as the greater quantity of commerce will be through the dam.

Character of foundation.—The original idea was to locate the lock so that the inside of land wall would be near low-water mark, and the contract for stone was made for this location. It was found, however, upon a further study of the site, that this location would greatly narrow the river, and, as the project was for a stationary dam, so restrict its waterway as to probably cause serious trouble in flood times, and it was therefore decided to place the lock about 90 feet farther in the bank. This was done the more willingly, because the bed rock has a decided declivity just outside the low-water line, and to have built on the original site would have required very much more stone, particularly should the bed rock be so fissured as to require a floor in the lock chamber. While the new location materially decreased the quantity of masonry in the lock, it greatly increased the amount of solid rock and earth to be excavated, both for the lock itself and its approaches, as the bed rock showed above low water at about the face line of river wall and was 16 to 20 feet higher at back of land wall.

Description.—The lock, which is of sandstone masonry, is 255 feet in length, with a distance between quoins of 190 feet, and is 52 feet in width. The walls originally stood 28 feet above the lower miter sill level, but were lowered 7 feet after the plan of dam was changed. The chamber faces of lock walls are vertical and are crandall-faced; the outer faces are "stepped" at each course, and are of pitch-faced masonry; the ends are also of pitch face and are vertical. The bases of the land wall and of that part of the river wall adjacent to the chamber are 15 feet wide, and those parts of the river wall about the gates and above the upper gate and below the lower one have a base of 21 feet. The coping along chamber is 7 feet 6 inches on each wall, while on the larger portions it is 15 feet 6 inches on river wall and 15 feet on land wall. Wing walls project from each end of land wall into bank.

The lower miter sill was placed 9 inches below the low-water mark of 1883, and the upper one 10 feet above the lower. The change in plan caused the difference in level to be reduced to 2 feet.

The gates are of wood and are of the miter pattern. They are operated by hand.

Temporary dams.—Means for coffering the lock are provided in a needle dam at one end of lock, and a shutter dam at the opposite end. The needle dam has three trestles fastened to the lock floor, which, when raised, support a beam near their ends. This beam also enters the walls at its ends and is there supported. A heavy oak sill is bolted to the bed rock across the lock along one side of these trestles and the needles are supported by this sill at bottom and by the beam, just mentioned, at top. A movable walk way is provided on top the trestles for use in handling the needles or communication between the walls.

The shutter dam consists of 13 shutters 3 feet 8 inches wide, hinged to the floor and supported by props resting against hurters placed in the floor masonry. The heads of these props are hinged to shafts made fast to the shutters near the middle of their height. This dam may be raised from a boat or from lock wall with a crab or capstan.

The cost of lock, including everything properly chargeable, was $120,371.81.

MOVABLE DAM.

General description of a needle dam.—A needle dam consists of (1) a row of trestles placed parallel with the current, turning in castings fixed to the floor and connected with one another in the upper part, when they are upright, by bars and walk way, and (2) wooden needles placed close together against the upstream side, resting on a sill at the bottom and on the connecting bars at the top. When not in use the trestles are lowered to the floor where they are protected from injury by the sill which supports the bottom of the needles when up, and the needles are removed to a safe place for storage. Heretofore the placing of the needles has been done by hand, and their sizes have necessarily been such as one man can conveniently handle. The trestles have heretofore been raised by a portable crab carried along the footway. The earlier needle dams sustained pressures of less than 4 feet, but their sizes were gradually increased until the heads, in extreme cases, were more than doubled during certain seasons. The needles on the dams of the Belgian Meuse, which is probably the best foreign example of improved needle dams, are 3¼ inches wide, 4¾ inches thick, and 12 feet 4 inches long, and weigh 55 pounds each. The pool level is 10 feet 2 inches above the sill of the pass, and the maximum head may reach 8¼ feet.

Dimensions and their determination.—The successful working of a movable dam depends to a considerable extent upon the height of its sill and the length of its waterway; that is, the fixed parts should cause very little fall over their crests when the movable parts have been taken out, otherwise navigation will be interfered with at the stage just preceding that which necessitates the raising of the dam.

The dam at this place is divided by a pier into two parts, the Navigation Pass and the Wier. The purpose of the former, as its name implies, is to accommodate navigation, while that of the latter is for the passage of surplus water. The pass is 130 feet long with its sill about 1 foot below the low-water line of recent years and at the low-water mark of 1883.

The Weir is 140 feet in length and its sill is 6 feet above that of the pass. The normal height of pool is 13 feet above the pass sill.

The total cost of movable dam, including every item that should be charged to the construction of pass, weir, pier, and abutment, was $73,697.74, or $245.66 per linear foot. Of this the substructure cost $226.48 and the superstructure $19.18 per foot.

Report of Maj. D. W. Lockwood, Corps of Engineers.—The considerations which led to the adoption of the dimensions given the parts of this dam are set forth in a partial report which has not been published, made by Maj. D. W. Lockwood, Corps of Engineers, to the Chief of Engineers, dated March 1, 1893, an extract from which is as follows:

"The Board of Officers of the Corps of Engineers, constituted by Special Orders No. 31, headquarters Corps of Engineers, Washington, D. C., May 20, 1891, 'to consider and report upon the subject of the dam to be built in the Big Sandy River near Louisa, Ky.,' in its report dated November 20, 1894, states as follows: 'After a full and careful consideration of all the elements determining a decision, the Board are of opinion that the best type of dam for the site at Louisa is a needle dam, and they recommend the substitution of that type for the fixed dam. It is further recommended that the height of the dam from the sill of the pass to the top of the wickets be fixed at 13 feet, and that the dam be built across the river opposite the tail wall of the lock as is done in our practice, leaving all other details to be wrought out by the officer in charge.' This recommendation of the Board was approved by the Chief of Engineers under date of November 20, 1891.

"As the Big Sandy is subject to sudden changes, i. e., to rises of various heights which frequently run out in a very short time, it is important that the character of the construction of the dam be such that it can be operated rapidly, and within certain limits as to rises, without interruption of communication between the banks.

"The dams on the Meuse have footbridges raised 18 inches above the normal level of the pool, so that a slight rise will not flood it and thus cut off communication across the river. These dams, however, have the pass only closed by needles, the weir being furnished with Chanoine wickets.

"This plan would hardly work on the Big Sandy, as the low-water discharge would not be sufficient to supply the leakage, even with the joints between the wickets covered; at certain stages, also, there is considerable drift in the stream, and this could not pass by the weir with the wickets en bascule, while in the case of a weir closed by needles these can be removed, and as many trestles next the abutment as may be found necessary can be lowered to permit the drift to pass.

"The type of dam adopted for the Big Sandy is similar to that employed on the Meuse for closing the passes. The trestles, however, instead of being forged out of iron with a rectangular cross section, are built of channel iron joined by gussets and rivets. A different escape for the bar supporting the upper ends of the needles, the design of Mr. B. F. Thomas, assistant engineer, has also been adopted. The trestles are spaced 4 feet apart between centers.

"The dam is divided into two parts, separated by a pier, the Navigable Pass, through which the commerce of the river will pass when the natural stage is sufficiently high, its sill being placed at or below the level of the highest natural obstruction in the river, and the weir, the sill of which is placed considerably higher than that of the pass. One of the functions of the latter is to carry off the surplus water beyond what is required to maintain the pool, at least for stages up to the one at which the natural river is navigable, and when the dam can be lowered entirely.

"In determining the length of sill of pass, the conditions that determine it are that it shall present an opening that can be readily run by rafts and tows of the kind that can navigate the Big Sandy descending, and steamboats going upstream, while considerations of economy require that it shall be as short as possible consistent with the service required of it.

"To satisfy the first condition, it is thought that the pass should have an opening of 130 feet. During the season of 1891, the lowest water recorded was 1.25 feet above the low-water level at the time the lock was built, and the discharge, 160 cubic feet per second, would indicate a close approximation to lowest water. With the gauge reading 1.25 there were from 8 to 10 inches of water on the principal shoals, so it is concluded that if the sill of the pass be placed at the level of low water, as originally determined, or 0.75 of a foot above the lower miter sill of the lock, it will satisfy the condition of not being an additional obstruction.

"The elevation of the sill of the pass being determined, as well its length, the next question to be settled is the difference of level between the sills of the pass and weir. As the head-bay and gate recesses would be liable to sand up, and a deposit of sand occur in the partially dead water below the lock should the gates be closed while the pass is open, the area of discharge through the lock may be taken into account in the determination of the height of the sill of the weir, as this elevation results from the consideration of the discharge of the river, and the area of discharge through the pass and lock up to the stage which just covers the sill of the weir, with the condition imposed that the swell head, produced by the partial contraction of discharge area, shall not be sufficient to seriously interfere with navigation up or down.

"During the season of 1891 discharges, areas of discharge, and mean velocities were measured through two rises. The first reached a height of 11.15 feet, July 25, and the second a height of 15.45 feet, August 25.

"The discharge and mean velocities deduced from observations made during the rise of August 25, taken on account of its greater range and also because the discharges for stages up to the probable elevation of the sill of the weir are greater than those obtained in the first case, are as follows:

Stage.	Discharge.	Mean velocity per second.	Stage.	Discharge.	Mean velocity per second.
	Cubic feet.	*Feet.*		*Cubic feet.*	*Feet.*
5 feet	3,319	2.72	11 feet	12,585	4.06
6 feet	4,910	2.99	12 feet	14,238	4.21
7 feet	6,362	3.21	13 feet	15,938	4.30
8 feet	7,750	3.42	14 feet	18,900	4.64
9 feet	9,088	3.56	15 feet	20,850	4.71
10 feet	10,525	3.72	15.45 feet	21,500	4.70

"Assuming a value of 0.5 of a foot for the swell head, the question then is to determine the maximum stage of the river, the discharge corresponding to which will pass through the pass and lock without causing an increase in depth of water above the dam over that below the dam exceeding 0.5 of a foot. This will give the elevation of the sill of the weir above the sill of the pass.

"To determine this the Chanoine formula of page 86, "Canalisation de la Meuse," is used, to wit:

"$Q = M(LH+L'\ H')\sqrt{2g(Z+h)}$; in which
"Q = discharge of river per second;
"M = constant depending on stage;
"L = length of pass;
"L' = length of weir;
"H = height of water below dam above sill of pass = stage in this case;
"H' = height of water below dam above sill of weir;
"h = height due to velocity of approach $= \frac{V^2}{2g}$.

For any stage H the discharge through the pass will be $Q' = M\ (130\ .\ H)\sqrt{2g\ (Z+h)}$, and through the lock $Q'' = M\ [52\ (H-1.25)]\ \sqrt{2g\ (Z\ h)}$, as the upper miter sill is 1.25 feet higher than the sill of pass, so that for the pass and lock $Q = Q'+Q'' = M(182\,H-65)\sqrt{2g(Z+h)}$, for $H=5$ feet, $M=.703$, $V=2.72$ feet, and the equation becomes $Q=.703\times845\times8.02\times.784=3{,}735$ cubic feet, which is considerably greater than the discharge corresponding to a 5-foot stage. Making H in the formula equal to 6 feet, M becomes equal to .71, $V=2.99$ feet, and there results $Q=0.71\times1027\times8.02\times0.8=4678$ for the discharge by the lock and pass with a swell head of 0.5 of a foot. Z being taken equal to 0.5 of a foot and the sill of the weir being 6 feet above that of the pass, at a 6-foot stage the discharge over the weir will be $L'\times0.45\times8.02\times0.5^{\frac{3}{2}}$. Taking L′ equal to 140 feet, the discharge over the weir becomes equal to 180 cubic feet per second, so that the quantity of water that can pass the dam per second, the lock gates being open, without producing a greater swell head than 0.5 of foot is 4,858 cubic feet. The discharge of the river corresponding to a 6-foot stage is 4,910 cubic feet per second, so that the swell head corresponding to this discharge would be but little in excess of 0.5 of a foot.

"In determining the length of the weir the following conditions must be satisfied: First, the area of discharge afforded by the weir must be sufficient, when taken in connection with those of the pass and lock, to permit the passage of discharges corresponding to all stages up to the level of the top of pier and abutment without causing a greater swell head than 0.5 of a foot; second, the discharge area of the weir should be sufficient to pass all discharges corresponding to stages up to that at which the natural river is navigable without the removal of any needles from the pass. It may be stated, however, that the second condition will be satisfied by a length of weir that will satisfy the first.

"To determine the length of the weir, the elevation of its sill being fixed, the formula of Chanoine modified to take into account the discharge through the lock is used, to wit:

"$Q=M[LH+52(H-1.25)+L'H']\sqrt{2g(Z+h)}$; or, substituting for L its value already determined, 130 feet, the formula becomes $Q=M(182H-65+L'H')\sqrt{2g(Z+h)}$; making H equal to 7 feet, H′ becomes equal to 1 foot and the formula becomes $Q=M\ (1209+L')\sqrt{2g(Z+h)}$. For a stage of 7 feet $Q=6{,}362$ cubic feet, $M=.73$, $h=\frac{V^2}{2g}=\frac{(3.21)^2}{2g}=0.160$ and $(Z+h)^{\frac{1}{2}}=0.812$, whence L′ becomes equal to 129.3 feet.

"For high stages the formula of Chanoine and de Lagrene, on page 88, Canalisation de la Meuse, is used, to wit: $Z=1.5\ V^2\left(\frac{S^2}{S'^2}-1\right)\frac{1}{2g}$, in which Z = swell head, V = mean velocity before construction of works, S = discharge area of river before construction of works, S′ = discharge area after construction of works = LH+L′H′, and 1.5 is a constant for cases where the lock gates are open. Transforming the above equation and substituting for $2g$ and Z their values 64.3 and 0.5, respectively, there results $S'=\frac{(1.5V^2S^2)^{\frac{1}{2}}}{(32.15+1.5V^2)^{}}$. For the highest stage observed $H=15.45$ feet, $H'=9.45$ feet, $V=4.7$ feet, and $S=4{,}576$ square feet, and $S'=LH+L'H'=3{,}260$ square feet $=$ 2,008.5 square feet + 9.45 L′, whence $L'=132.4$ feet.

"As the stage that would just cover the pier and abutment is 16.5 feet, it is thought best to fix the length of the weir at 140 feet, particularly as the rises in the Sandy during the summer are generally quite sudden when the Ohio is apt to be low.

"With the sill of the pass at low-water level and 130 feet long, the sill of the weir 6 feet above that of the pass and 140 feet long, for the 8-foot stage Z becomes equal to 0.53 of a foot, for the 9-foot stage it is less than 0.5 of a foot, and when the pier and abutment are submerged Z will not exceed 0.5 of a foot appreciably. * * *"

Innovations.—The arrangements proposed in the foregoing report were maintained, except that, instead of adopting the design of trestles proposed another, requiring less height of sill for its protection, was used. This form of trestle was invented by the writer several years since, but this is its first practical application. It does not superpose and requires but little depth of recess.

This change of plan was brought about by the discovery that the recess below the pass sill was constantly filled with sand, gravel, and stones, and it was believed it would be impracticable to keep it sufficiently clean to properly maneuver the trestles.

The new form of trestle suppressed the axle and diagonal bracing of the old and gives a decided inclination to the posts and permits the trestles to lie one within another when down, instead of piling up on each other as in the old form. Thus it is that a sill of sufficient height to protect one protects all, and a very shallow recess answers the purpose and greatly reduces the liability to sand up.

The method of maneuvering the trestles was also changed from that in general use.

In the maneuvers of the trestles as heretofore generally practiced a chain is attached to each trestle and a crab is moved along the foot bridge, winding in the whole length of chain in order to raise the trestle. At best this is slow and laborious. The new method connects all trestles by a continuous chain, which, when wound over a chain wheel on a crab located at lock wall, will successively bring the trestles into position by the winding in of a very short length of chain.

There are several modifications in the original designs of the trestles made with a view to reducing the time of maneuvering, but they are of little importance and will not be specially mentioned here.

To meet the unprecedented conditions in a needle dam of a depth of pool of 13 feet on the sill with very little downstream pressure and with the chance of the head being increased 1 foot at times by the sudden appearance of a freshet which might materially raise the level of the upper pool before the dam could be lowered, it was necessary to provide needles of much greater thickness and width than are in use elsewhere. In order to handle needles of this size the old method of placing by hand was out of the question, and it was necessary to devise a new method. This was accomplished by placing suitable machinery on a boat, which boat is used as a storehouse for the needles when not in use.

Character of foundation.—The dam is founded on sandstone varying in depth below low water of from 3 feet at lock wall to 24 feet at abutment. The material overlying this rock was largely sand and clay, but the part underlying the weir was covered with a 4-foot layer of gravel and small bowlders. The rock was rather soft on top and at places shelly and filled with coal seams. The soft and shelly parts and coal were all removed, and the bed prepared was a fairly good foundation upon which to build.

Substructure.—The substructure is of concrete and sandstone masonry. In the pass it is 22 feet and in the weir 17 feet wide at coping. The pass masonry averages about 12 feet in height and the weir about 24 feet. Immediately overlying the bed rock is placed a layer of concrete varying in thickness, but averaging about 4 feet. On this bed of concrete and near its upstream and downstream edges are built two parallel masonry walls. The space between these walls is filled with broken stone to within 7 feet of coping and above this is concrete, and the whole is coped at top to receive the superstructure. Toward the upstream side the masonry is raised and a sill is fastened for the support of needles and protection of trestles.

Trestles.—The pass is closed by 31 and the weir by 34 steel trestles, spaced 4 feet between centers. These trestles terminate in eyes at bottom and are connected to journal boxes by pins. The pass trestles are 15 feet 2 inches high and weigh 1,140 pounds, and the weir 9 feet 8 inches in height and weigh 920 pounds, and have a base of 9 feet 10½ inches and 6 feet 5 inches, respectively. The width on top is 3 feet 8 inches, and the floor or walk way is 3 feet 2 inches. The trestle frame is made of 4-inch steel channels weighing 7.25 pounds per foot. The upstream post is single. The downstream post is made of two pieces set apart and braced together. These two channels are close together at bottom and diverge toward top so that one of them comes to the upstream post at level of connecting bar, above which point it is riveted to the upstream post, and the other goes to the top of trestle. They are assembled by gusset plates and rivets. The frame thus formed is connected by two horizontal braces made of angle iron and riveted to the outside. A suitable bracket frame for carrying the floor is also riveted to the outside of the main trestle head. The bar which forms the upper support of needles and connects one trestle with another when all are standing is hinged vertically at pool level so as to swing horizontally. The opposite end is formed into a hook on its upstream side which engages with a lip or projection on the next trestle. It is held in this position by a crank-shaped rod known as the jack post, which may be turned from the walk way by a wrench when it is desired to let the bar swing free, the hook end passing through the space formed by bending the post. When in use the post is held from turning by a latch which is raised out when the wrench is dropped over the head of the post.

The trestles are connected at top with sheet-iron floors hinged to and falling with them. The opposite end hooks into the next trestle at two points, and a latch, moved by the foot, holds each section in position. Thus the trestles are rigidly connected by two independent constructions, and there is still a third, the maneuvering chain. The cost of trestles and their connections with masonry was $3,344.64.

In a frame bolted into the head of each trestle is a combined ratchet and chain wheel turning on a horizontal axis. Over this wheel a chain passes from one end of the pass to the other and another chain for the weir. One end of this chain is fastened to the last trestle, the one next the pier in pass and abutment in weir. The opposite end is wound on a chain crab located one on the lock wall and the other on the pier. By means of a pawl dropping into the ratchet the rolling of the chain wheel may be stopped, and when this occurs the trestle is attached to the chain, and the winding of the crab will move it as desired. For instance, it is desired to lower the trestles; the support bars are first all released, then the floor section of the end trestle is unhooked and the crab turned backward; the trestle, being pushed away by the attendant, pulls the chain as it goes down. When it has proceeded, say, 4 feet, the pawl of the next trestle is dropped by the attendant, and thus it becomes attached to the chain. The releasing of the floor locks the pawl in ratchet so that it can not come out while trestle is down.

To proceed with the lowering the floor section is again released and a second trestle starts down. As more chain is unwound other trestles are attached and several will thus be under way simultaneously. To raise the dam the chain is wound on the crab, or rather over a chain wheel on crab, where it falls into a recess provided for it. The first trestle (being the last lowered) is brought up and the attendant standing on wall grasps the floor, which rests on the chain, and raises it a few inches. This raising depresses the opposite end onto the point of pawl and lifts it out of the ratchet and thus allows the wheel to turn and releases the trestle from chain. The pawl is held out of the ratchet by an automatic device which drops under it. As each trestle comes up it is released from the chain by the attendant standing on the floor of the last one raised and slightly elevating the end of the floor section just coming up. The floor section is then hooked to the neighboring trestle while the crab men are winding; thus the entire maneuver may be performed without stopping the crab, and the winding in of 4 feet of chain each time brings a trestle into place.

Needles.—The needles are of white pine and are 12 inches in width. The pass needles, 14 feet 3 inches long, are 8½ inches thick at bottom and 4½ inches at top and weigh when wet about 265 pounds. The weir needles are 8 feet 3 inches long, 3½ inches thick at bottom, and 2½ inches at top, and weigh about 80 pounds.

All needles are provided with iron straps at top and bottom and have iron handles at top for convenience in handling and suitable attachments for connecting chains for placing and removing them. In the sides of the pass needles a shallow groove is cut in which it is proposed to introduce strips of rubber, should it be found necessary, to prevent leakage to any considerable extent. The cost of the needles was $1,353.82.

The pass needles when not in use are stored on a boat built for the purpose. This boat is provided with two overhead tracks carrying trolleys for lifting the needles from the piles and carrying them to the end of the boat when they are to be put in the dam and for piling them when they are to be stored. All irons are countersunk so that the needles lie flat on each other when piled.

To place a needle in the dam it is suspended at its center of gravity from the trolley by a chain passing over a sheave in trolley frame and pushed out until the head touches the footbridge, where it is held in the position desired until the butt is lowered by slacking the trolley chain until the needle strikes the sill.

To regulate the pool alternate needles are pushed away from the support bar at top and held out by wooden pins, about 15 inches long, resting against the bar and the lower side of needle. These spaces will pass a large quantity of surplus water.

To remove the needles a chain about three times the length of dam is attached by hooks to eyes near the top of the needles. This gives an average length of chain of about 3 feet to each needle, and by pulling one end of the chain upstream the needles are successfully removed, the principal strain having been overcome in one needle before another is started.

Under the head of "Maneuvers," the methods of operation of both trestles and needles will be more fully described.

Drift boom.—This river carries a considerable quantity of drift. While this usually comes on stages of water at which the dam will be down, yet there are times when it arrives in great quantities with the first indication of a rise. This happens when a severe storm occurs in some of the neighboring creeks and causes a freshet of sufficient force to break the tie and log booms in the mouths of these creeks. This drift is a menace to the dam, and should it come at a time when it was necessary to lower the trestles it would interfere greatly with this operation, if not seriously damage, or even destroy, the trestles. To prevent such a calamity a rudder boom has been built, which reaches from a point above the weir on the Kentucky side of the river to the crib at head of river wall of lock. As the river makes a pronounced bend at the point of attachment of boom, the boom is little less than a prolongation of the shore above, and it will readily guide the drift into the lock, where it can be locked through. In construction the boom consists of four parallel timbers bolted rigidly together and having rudders at intervals of 30 feet. The movement of these rudders is controlled by a wire rope which connects them all and is wound on a capstan at ends of boom. Thus by setting the rudders at any desired angle the boom can be held out in the stream at any point required. The cost of this boom, exclusive of the wire rope, which is an old one that has been in use on the works for many years, was $1,231.83.

II. CONSTRUCTION.

LOCK.

Cofferdam.—In the construction the site was inclosed by a pile and crib coffer. All work was done by hired labor. As the machinery was delayed in arriving, the piles were driven by horsepower and the sheet piles by men with wooden hammers. The coffer was 13 feet high, counting from low water, and the outer row of piles extended about 10 feet below water and 6 feet into the material of the river bed, overlying the rock. The inclosure formed by the piles and sheathing was filled with clay, well rammed, as were also the cribs forming the ends of the cofferdam. The outside was lightly banked up to about ordinary water line. A vertical centrifugal pump with 12-inch discharge was placed in one corner of the coffer and served to keep the inclosed space dry during the excavation and construction. The coffer deserves mention because of its very small cost. It consisted of two rows of piles spaced 8 feet across the line and 6 feet with it, capped at top, and with longitudinal wales at low-water mark and at one-half the height of pile above that point, spiked onto the inner faces of piles. Ties reaching from one row to the other were also spiked onto the piles to prevent spreading. The sheet piles were 2-inch plank placed against the wales and driven to bed rock, over the joints of which were driven 1-inch plank as deep as they could be forced without splitting. At the ends of the coffer the proximity of the bed rock prevented the use of piles, and cribs were built from the outer wall of pile section into the bank. As the excavation proceeded braces were set against the top of the inner row of piles and seated in the bed rock outside the site of river wall at foot. The cost of this coffer was $7.16 per foot of its length, or $2,747.65.

Excavation.—It was necessary to excavate to a depth of 3 feet below low water at site of lock in order to properly seat the lower miter sill and secure the required depth of chamber. The lower approach to lock was blasted to about 1 foot below low-water level and the upper approach to upper miter-sill level. The change of plan later on required this entrance to be still further lowered. It was proposed to utilize much of the excavated rock in the construction of the fixed dam and the balance of it in the protection of the river banks, which had been cut by the water into wide and deep ravines and gullies. This caused the piling of the material in the river outside the cofferdam, from which place, on account of the change in plan to movable dam, it was removed later on, at considerable additional expense. The material to be excavated was mostly sandstone, overlying which was a good quantity of clay and earth. The rock was divided by a coal vein varying in thickness from 12 to 26 inches, and with this was considerable slate. With exceptions here and there, the rock was not an extremely hard one. The drilling was done with hand drills (jumper and churn), and the blasting with dynamite and blasting powder and electro-magnetic battery. The material was moved by wheelbarrows. The quantity excavated was 22,229 cubic yards, and the cost of same was $18,574.45.

Stone.—The stone, which is a good quality of sandstone, was taken from local quarries and was prepared and furnished by contract. There was 11,186.52 cubic yards, which cost $66,285.22.

Laying plant.—A self-propelling traveling derrick was used in the stone yard for transferring the stone from the various piles made by the contractor to cars at the head of double-track incline leading to the middle of the lock coffer. A wire rope passing around a drum controlled by a brake was used to lower the loaded car, which at the same movement brought the empty car to the top. The loaded cars were taken on tracks to the various derricks, where they were unloaded as the stones were required. The land wall was laid with a "walking" derrick operated by hand, standing on a car traveling on a track running parallel with the wall and just behind it, resting on top the ledge of rock upon which the lock is built. The top of the mast was held by two stiff legs reaching back to and traveling on a track on top of the bank. The movement of the derrick from point to point was accomplished by attaching a rope ahead and winding it on the crab. At the same time the stiff-leg trucks were moved with crowbars. The river wall and miter walls were set with the regular type of boom and guy derrick, located at convenient points and operated either by hand or steam power. Only two hoisting engines were used, and they were single-cylinder, single-drum engines, supplied with steam from the boilers used for the pump engine. The cost of this plant was $8,823.98, of which one-half only, or $4,411.99, is properly chargeable to the lock construction, as the plant was used to the completion of the works.

Masonry.—The masonry was laid by hired labor, and cost, including labor, cement, and stone, and excluding cost of plant, for 9,054.28 cubic yards, $71,591.56, or $7.90¼ per cubic yard. The average cost for labor, sand, and cement was $2.10 per cubic yard. Covering all the items that can properly be charged to masonry, including labor, cement, stone, and one-half the cost of the whole plant, the average cost per cubic yard was $8.39 for the entire lock. The quantities of masonry are distributed as follows:

	Cubic yards.
River wall	4,244.14
Land wall	3,877.10
Wing wall	205.06
Head-bay and miter walls	727.98
Total	9,054.28

The classes of stone used are divided as below:

	Cubic yards.
Special stone, coping, quoins, etc	636
Dressed face	1,545
Pitch face	995
Squared stone (jointed backing)	830
Backing	5,048.28
Total	9,054.28

Cement.—The cement used was F. O. Norton's Rosendale, and was very satisfactory in every way. It was purchased under the following specifications: (1) Uniform in character; (2) 90 per cent to pass through sieve of 2,500 meshes per square inch; (3) not to set in less than twenty-five minutes so as to bear 4-ounce weight on one-twelfth-inch wire.

A Fairbanks testing machine was used, every tenth barrel being tested at first, the number decreasing later on.

Mortar.—In mixing the mortar for laying the masonry, two parts of sand were used to one of cement. Owing to the fact that the cement was delivered by rail upon the opposite side of the river from the lock, and also because the sand could only be gotten upon that side, most of the mortar was mixed there and transferred in a dump box, which was first hoisted by a horse to the top of a tower made of poles, where it was attached to a pulley traveling on a wire rope reaching across the river. Its speed in descending the wire rope was regulated by a small line wound on a spool in the tower, and its return was effected by winding in this line. It was possible to stop or start the box at any point desired and dump the mortar on platforms, from whence it was distributed to the masons as needed.

Concrete.—Concrete was used only for leveling up inequalities made by blasting out the foundation, and there was only 57 cubic yards. The mortar was mixed similar to that used for masonry, and the broken stone incorporated with it by the use of shovels and hoes. It was taken to points required in wheelbarrows and was rammed in place by wooden mauls. Fifty-seven cubic yards was used, costing $276.79, or $4.85 per yard.

Miter sills.—The miter sills are of white oak, bolted to the bed rock at lower gates and to the masonry and bed rock at the upper gates. The sill for each gate is in two pieces, one on top the other, and they are 16 inches thick, or wide, up and down stream. One end of each sill is cut to fit the walls and the others miter on each other. The masonry on the lower side and against which the sills press is made of voussoirs, the radius being 40 feet. The cost of sills was $365.44 in place.

Valves.—As originally built the lock was to be filled through culverts in the lock walls; the change in plan necessitated lowering the upper miter wall and consequent destruction of culverts, and the filling of the lock now takes place through valves in the upper gates. The discharging apparatus remains as originally put in and is as follows: In the lock walls culverts are built leading from an opening in the face in gate recess to a similar opening in the face below the gates; thus the culvert connects the water in the lock chamber with that of the lower pool. The openings above the gates are closed at will by cast-iron valves or wickets about 6 feet high by 5½ feet wide, having vertical shafts through the central parts, which reach the top of the walls, where they are connected with suitable machinery for operation.

Movable iron screens protect the valves and culverts from drift. The amount expended on this part of the work was $1,020.20, including ironwork, machinery, and putting the wickets and frames in place.

First gates.—The first gates were built before the plan of dam was changed, but the reduction of the height of lock and removal of upper miter wall caused by this change of plan rendered the upper gates useless, and the delay in the completion made it inadvisable to use the lower ones, much of the timber therein having decayed badly. However, as they were part of the original structure, they will be briefly described. They were of the regular mitering pattern, without heel or toe post, the arms being separated by short blocks in upper parts and built close in lower parts. They were built of white oak, hewn one-half inch larger than desired size and then counter hewn and planed to the exact size. On account of the great thickness and length, the timber was very expensive to begin with, and this expense was greatly increased by the amount of work required to get it to the exact size. The lower gates were 28 feet 9½ inches high, and the upper ones 18 feet 7½ inches. The main arms were 29 feet 6 inches long, 18 inches wide, and 12 inches thick. The upper gates were built solid, 7 feet 6 inches high, and then the arms were spaced at increasing intervals from 6 inches at bottom to 25 inches at top. The lower gates were solid, 8 feet 9 inches high; the space between the remaining arms ranged from 8 inches at bottom to 41 inches at top. The end blocks used for spacing the arms were 4 feet long and the middle ones 3 feet long, and all were the same width as the arms—18 inches. The sheathing was placed vertically and was 3 inches thick and 8 inches wide, and extended from the top arm of the solid part of gate to the top arm of gate, rabbets being cut in the members to receive it. The whole frame is held rigidly together by vertical iron straps countersunk in the timbers, through which are passed numerous bolts. Two diagonal straps reached from a cast-iron bonnet at top of heel to a pin passing through a strap near the toe; this bonnet was slotted to receive a bent strap which was held to it by a pin; the two ends of this strap connected by turn-buckles with fixed anchor straps in the masonry.

New gates.—The new gates, made necessary by changes in plan and delay in completion of works, are much lighter and cheaper than the old ones, although the old irons were used, being altered to suit the new dimensions. The timber is long leaf yellow pine. Each arm is made of two pieces 9 inches thick, bolted together. The plan of construction is similar to that of the old gates, except that it was necessary to introduce steel-girder frame for the filling valves near the bottom of the upper gates. The timber was purchased already dressed on four sides to the desired dimensions, and this, coupled with the fact that each stick has only half the thickness of the gates, rendered these gates much less expensive than the former ones, the dressing of the timber for which was all done by hand and included a reduction in breadth of one-half inch. The lock is filled through four valves or wickets in each upper gate; these valves close spaces 4 feet in length by 2 feet in width; they turn upon steel journals placed horizontally through the center, which fit into slotted cheek plates made so as to permit the removal of the valves; along the outer edges a strip of rubber is fastened to prevent leakage through the opening; an arm projects from the under half of the valve and to this the operating rod is attached. To open the valve the rod is lifted by means of a rock bolted to its upper end, working in a pinion to which a lever is fastened; these levers are so placed as to lie below the level of the top of gate, both when the wicket is shut and open. The cost of the gates was $6,270.26, including iron from old gates; or $3,165.50, without counting cost of old iron, which has been accounted for in cost of first gates.

Filling behind lock.—It is properly a part of the lock construction to connect the masonry with the bank behind it. Although this lock was located well in the bank, yet it was necessary to slope the bank resting on the ledge of rock on which the walls were built and, after the completion of the masonry, to refill this space. In the first place a perforated tile drain was put in above lower pool level along the back of land wall for the purpose of draining off the surface water which might otherwise collect there. The cost of this drain, including tile and labor, was $76.64. On top of this was placed broken stone for a height of 8 feet, and then the embankment was commenced. It was largely of broken stone taken from the lock approaches, and contained 3,300 cubic yards, and cost, charging half the expense of blasting, $1,819.66.

Miscellaneous work.—In the construction of the lock there were many small items, amounting to very little when considered separately, but required considerable labor and expense when taken together. Thus there were the necessary fences, buildings for storing cement and tools, shops, engine sheds, boiler houses, magazines, office, etc.; the ladders and other iron work fitted to the lock outside of that counted in cost of gates and valves, various repairs to tools, machinery, etc.

The total cost of lock, including cofferdam, excavation, concrete, masonry, sills, two sets of gates, adjustable dams, valves, irons, temporary buildings, plant, embankment behind, and various other items, was $120,371.81.

PASS SUBSTRUCTURE.

General description.—The Navigation Pass, or, as it is generally called, simply the "Pass," is 130 feet in length and the masonry has a width of 22 feet on top. The bed rock on which it is built is about 3 feet below low water at lock and increases to 14 feet at a distance of 50 feet from the lock and is 16 feet at the pier. The substructure is of masonry and concrete. Near the upstream edge of the masonry is fastened a heavy wooden sill, the purpose of which is to support the needles when the dam is up and protect the trestles when dam is down.

Cofferdam.—The site of the pass was covered by a high waste-dump of rock excavated from lock. This was dredged out and boated away, and two rows of piles, reaching from the lock 170 feet out into the river, were driven above and below the proposed dam. Parallel with the line of dam the piles were 8 feet between centers, and across the line they were 12 feet, the space inclosed was 36 feet wide, the piles were capped, wales were spiked on at water level, and sheet piles were driven to inclose these spaces, which spaces were filled with well-rammed clay. After dredging out the inclosure the two walls of the coffer were connected at outer end by a crib which was also sheathed and filled with clay and banked up on the river side with heavy material and riprapped. The walls were well braced apart at top, the braces being so spaced as to interfere as little as possible with the work inside the coffer. Owing to the character of the material surrounding and underlying this coffer much trouble was encountered in maintaining it and keeping it sufficiently dry for good work. The timber used, as well as the piles, except the sheeting, was that which had been purchased for the stationary dam, and the cost was nearly double that which new timber suitable for the purpose could have been gotten. Leaving out the cost of excavation necessary to begin the construction of the coffer, the cost was $4,899.63.

Excavation.—As has been mentioned, a great amount of excavation was required to prepare the site for the cofferdam; it was also necessary, after pumping out, to excavate to the bed rock inside the coffer. After this was well under way it was found that the water from the river was forcing large quantities of sand into the inclosure under the clay of the coffer, and thus undermining the clay and the sheet piling; this continued until the clay had reached the rock.

At the end of the pass next the lock it was necessary to blast out the bed rock to a depth of several feet in order to set the anchor bolts which hold the sill in place; toward the pier end the rock was shelly and soft, and at one point a depth of 10 feet was taken out before a material sufficiently hard to build upon was found; this excavation was made through soft sandstone, fire clay, and coal. The quantity of material excavated was 5,508 cubic yards of earth, broken stone, etc.; 280 cubic yards loose rock and fire clay, and 60 cubic yards solid rock, at a total cost of $1,458.20.

Concrete.—The concrete for the pass was mixed by hand, the amount not being deemed sufficient to justify the purchase of a mixing plant; the quantity, however, was greatly increased over the original estimate, because of the poor quality of bed rock, and had this been foreseen, a mixer would have been provided, as it was for the weir construction later on. The stone used was fairly hard sandstone, blasted from the approaches to the lock. It was broken by hand to a size which would pass through a 2-inch ring. The cement was Norton's Rosendale, used 1 part to 2 of sand, mixed dry on a large platform; the water was then added, and a vigorous stirring with hoes soon made a good mortar, into which the stone was cast, and the whole mass was turned up with shovels and wheeled to points required, where it was deposited in layers about 8 inches thick and rammed until the water covered the surface. It required 1¾ barrels of cement to the yard of concrete, and the greatest quantity that could be placed was about 110 cubic yards in twenty-four hours. The total quantity in pass was 850 cubic yards, and it cost $4,326.50, or $5.09 per cubic yard.

Stone cutting.—Although the stone used in this construction was largely taken from completed work, it was necessary to cut a large quantity of it for coping, sill stones, etc., and to pitch-face much of the backing for use in the wall faces. The cutting was done by hired labor and cost, for 480 cubic yards, $2,382.10.

Masonry.—At the time the lock walls were reduced, most of the stone was taken to the yard behind lock and piled away; the cutting was, of course, done at these piles, and in order to get this stone to the site of pass it was necessary to build a double-track incline 180 feet long down the bank and across the lower entrance of lock to the end of cofferdam; from the ends of this incline tracks were laid into the stone piles and out onto the cofferdam. A drum with wire rope placed at head of incline was used for lowering the stone cars and bringing up the empties. The sand was nearly all obtained from the opposite side of river, and required careful screening. The cement was the same used for all the masonry at this place—Norton's Rosendale. The mortar was mixed in proportion of two parts sand to one of cement.

The quantity of stone placed in pass was 230 yards special stone, 250 yards squared stone, and 99 yards backing; this made 595.28 cubic yards masonry, and the cost was $6,727.70, or $11.30 per cubic yard.

Sills.—The purpose of the principal sill is to support the needles when up and protect the trestles when down. The main sill, which runs the entire length of masonry near its upstream side, is made of the best grade of white oak obtainable in this locality, and consists in section of two pieces 16 by 17 inches each, lying one upon the other and rabbeted so as to lap 3 inches. The two pieces thus form a sill 31 inches high, but as 4 inches of it is let into the stone it stands but 27 inches above coping. On its upstream side is a tier of cut stone, which stones reach to within 5 inches of the top immediately against sill and slope up until they come to its level 2 feet away. The recess or projection thus formed receives the bottoms of the needles, the sill being cut to the angle the needles made with the vertical, and protected by iron sheeting. The sill is bolted at intervals of 4 feet to the masonry underneath, and is also bolted horizontally at intervals of 8 feet to the masonry upstream. The various sections of the sill are halved together with a 2-foot lap and laid with broken joints.

The upstream journal boxes for the trestles, as first designed, were let into the lower face of the sill.

It was found after completing the pass substructure that the sand filled in below this sill to such an extent that it might endanger the proper seating of the trestles and cause trouble in raising them. This led to the adoption of a new style of trestle, which permitted a sill of much less height. In order to reduce this height sills were placed at intervals of 4 feet between centers on the masonry floor below the main sill and at right angles thereto. These sills are 14 inches square and 12 feet long and are bolted to the masonry. On these the trestles stand, instead of on masonry as originally intended. The sills contained 11,116 feet B. M. timber, and cost $911.28 in place.

Fixed ironwork.—This consisted of tie straps and driftbolts for masonry, journal boxes for trestles, and anchor bolts and straps for sills. The original journal boxes put in were not suitable for the new design of trestle, and the lower ones were taken out when the trestle floor was raised. The upper boxes were left in, as they were embedded in sill. The new lower journal boxes were fastened to the trestle sills and the upper ones to the main sill. The trestle sills were anchored by six 1-inch bolts set in the masonry with cement and lead. The main sill was anchored down with 1¾-inch rods 10¼ feet long, at the bottom of which was a heavy cast-iron disk. These rods were set in as the masonry reached the proper level and concrete filled in over the disks. It was also anchored horizontally to the masonry above by bolts passing through the lower sill and by a strap passing through the upper sill and over the masonry to the masonry tie strap. At the level of the bottom of the coping tie straps connecting the upstream and downstream walls of the masonry were put in, spaced 8 feet between centers. The upstream ends of these straps were formed into a rod which passed through the horizontal anchor straps of the main sill; the lower end held a washer against the masonry. Each piece of coping along the upstream and downstream sides of the masonry was fastened to the masonry below by driftbolts 8 feet long set in cement. The quantity used was 54,742 pounds, and cost $1,889.99. The placing of the iron, which required considerable stone cutting and drilling, cost $384.61, making a total for fixed iron of $2,274.60.

WEIR SUBSTRUCTURE.

General description.—As many of the details of construction have been described, they will be omitted in the description of the weir. The weir is 140 feet in length, and is founded on bed rock at a distance of from 16 to 24 feet below low-water level, and has a width on top of 17 feet. A bed of concrete varying in depth from 4 to 6 feet was placed on the bed rock, and on top of this two walls extending across the river some distance apart were built. The bottom part of this space was filled with broken stone and the top coped over at a point a few feet above low water. The whole structure is surmounted by a cast-iron sill near the upstream side for the support of bottoms of needles and protection of trestles.

Cofferdam.—The experience with a narrow pile cofferdam for the pass was such that a much wider one was built for the weir. Although the foundation was much deeper than that of pass, there was no such trouble in preventing leakage and undermining as was encountered there. The coffer consisted of two rows of piles above and below the sills, 6 feet between centers with the line and 12 feet across it, cut off and capped at low-water line and surmounted by crib work rising about 10 feet higher. Sheet piling was driven in the usual way and cut off at bottom of cribs, and the cribs were lined with plank, and the inclosures thus found were filled with clay below water line. Above water the spaces were left open in order to add as little weight as possible, the intention being to fill them upon the approach of a rise, and as this condition did not occur they were never filled. At the abutment end of the coffer two rows of close piles were driven, placed in the form of an arch and connecting the upstream and downstream walls of coffer. At the pier end connection was made with the pass coffer, a part of which had been retained for that purpose. The timber used was that which had been purchased for stationary dam, was not well adapted to the purpose, and was much more expensive than was required for a cofferdam which was to stand but a single season. The coffer was well banked by the material removed from the site of work, much of which was of an excellent quality for the purpose. The cost of this coffer was $5,017.78.

Excavation.—As there was no dredge available, the excavation, both in preparing the coffer site and inside the coffer after completion, was done with men. The material was hoisted with derricks and engines and dumped outside, where it formed a good protection to cofferdam. The material was largely sand, although a vein of gravel was found near the bed rock. The quantity of material moved was 7,846 cubic yards, at a cost of $1,605.20.

Concrete.—The foundation or bed rock was covered with a monolith of concrete over 4 feet in depth and 24 feet wide. Concrete was also used for filling the spaces between the weir walls toward the top. The stone was broken by hired labor with small hammers. A mixer was improvised from machinery and material on hand. There was 746 cubic yards put in and the cost was, $3,320.88, or $4.45 per cubic yard.

Stonecutting.—It was necessary to cut coping and other stone from those removed from old abutment and others on hand. This work was done by hired labor, and cost, for 1,012.65 cubic yards, $2,982.81.

Masonry.—The stone for weir masonry was largely taken from old abutment. A track was built from coffer to that point for its transportation. A track was also laid to the pile on top of bank, where most of the special stones were. The same proportions of sand and cement were used for mortar as for the work already described. The quantity of masonry laid was 1,883.11 cubic yards, at a cost of $15,961.36, being $8.47½ per cubic yard.

Fixed ironwork.—The fixed ironwork of weir consists of a cast sill along the upper part, tie-rods, anchor bolts, driftbolts, and journal boxes. The work is quite similar to that of pass, except as to sill. This is a heavy hollow casting, made in 8-foot sections and held to masonry by long bolts, having a disk embedded in the masonry at bottom. The sill is filled with mortar. The masonry above the sill is exactly like that of pass. The quantity of wrought iron used was 15,750 pounds, and of cast iron 39,091 pounds, costing $1,601.59. The cost of placing was $430, making a total for fixed iron of weir of $2,031.59.

PIER, ABUTMENT, ETC.

Pier.—Dividing the pass from the weir is a pier 12 feet wide and 36 feet long. Below water line it has a rectangular plan, while above that the lower end is a semicircle and the upper end elliptical in shape. The foundation is similar to that of pass. The downstream end reaches in height to the 8-foot water level, and is there coped over. The upstream end rises about 3½ feet above upper pool level. Steps connect the lower and upper levels. A recess is formed on the pass side of the pier for the reception of the trestles when down. This recess cuts the pier almost in twain, and is covered by an iron grating. After excavating the site the pier was built in the pass cofferdam, and contained 364.91 yards masonry, the cost of which was $3,489.26, and 40 yards of concrete, which cost $173.60, a total of $3,692.86. The excavation amounted to 220 cubic yards and cost $38.50.

A cast-iron pipe, placed near the low-water level, and reaching from the head of pier in upper pool to back of trestle recess in lower pool and containing an eddy valve, operated from top of pier, was put in for the purpose of flushing out the trestle recess so as to insure the proper seating of the trestles when they were lowered. The experience gained with trestles of wicket dams, where the recess sands up sometimes led to the adoption of this device, but it is wholly useless in a needle dam, as by removing the needle immediately adjoining the pier a current can be sent into the recess which will remove anything liable to collect there. The cost of this apparatus was $265, which, together with other iron work of pier, makes a total of $307. The cost of pier was $4,854.56.

Abutment.—The weir terminates in an abutment resting on a concrete foundation and extending in height to a point 10½ feet above weir sill, or 3 feet above pool-level. The abutment is 21½ feet long and 17½ feet wide. A recess about 6 feet square is built in the face to receive the trestles of the weir. This is covered by an iron grating. The space behind the abutment back to the cofferdam was filled with broken stone, 1,500 cubic yards being put in. The abutment contained 46 yards special stone, 190 yards pitch face, and 172 yards backing, in all 352 cubic yards masonry, 64 yards concrete, and the amount of excavation was 336 yards. The cost was $5,284.90, including masonry, concrete, and iron grating.

Addition to lock wall.—The outer face of river wall of lock was built of pitch-face masonry and was not vertical. At the point where dam joins it it was necessary to construct a wall having a vertical face; this was tied into the main wall and contained 16 cubic yards of masonry, and cost $191.71. The total cost of substructure of pass and weir, together with pier and abutment, was $68,519.28. To this we may add $5,178.46 for superstructure, giving total for movable dam of $73,697.74.

APPROACHES, PROTECTION WORKS, ETC.

Approaches.—Owing to the location of the lock in the bank much excavation was required above and below it to facilitate entrance and exit; in fact the approaches were entirely out of water during the dry season. Most of this excavation was solid rock, although this was overlain with a heavy covering of earth. As it was proposed to use much of the rock in the construction of a stationary dam, part of the material was piled in the river just outside the channel excavated below the lock and part of it was taken across the river and filled in behind the abutment and used for bank protection. Above the lock approach was not taken out so deep as below, where part of it was excavated in cofferdams, but its depth was considerably increased after the change of plan of dam made it necessary to lower the upper miter sill level. Considerable earth excavation was necessitated by the fact that sediment filled in badly below lock in winter, and where the excavation had not been completed in a single season it was necessary to remove this deposit previous to resumption of excavation.

The ledge, when blasted, was left quite rough, and this was smoothed down so as to present a fairly even surface to boats entering and leaving the lock.

The total quantity of material excavated (exclusive of reexcavation by dredge) was 35,416 cubic yards, and cost $18,419.70.

Cribs.—A triangular crib 30 feet long and 20 feet wide and as high as lock is built immediately above river wall. Its purpose is to ward off drift which previous to its construction lodged against the head of wall when gates were open, and often closed the lock. It is desirable at times to leave all the gates open, in order to prevent deposit in lower approach, and this causes a current through the lock which draws the drift against the walls. The point of this crib is covered with boiler plate, and it has been quite effective in ice as well as drift. It also assists greatly in directing rafts into the pass when the current sets strong toward lock. Its construction required 23,467 feet B. M. sawed timber, and 264 cubic yards broken stone, and it cost $813.68.

Retaining or protection cribs were built on top of the ledge for a distance of 400 feet above, and the same below the lock. They were about 4 feet in height and 6 feet in width, and were built of old timber which had been intended for use in the dam and was considerably decayed when put in. During the past season the cribs were replaced by light stone retaining walls. These cribs cost $961.30.

Parallel with the river and immediately below the abutment 100 piles were driven and capped, for the protection of the bank and for forming a toe for the paving. Its cost was $251, including timber. This brings the total cost under this head to $2,025.98.

Riprap.—The fact that so much rock was blasted in the lock approaches caused the use of more riprap on the banks above and below the lock and abutment than would have otherwise been the case. The bank is riprapped for a distance of 506 feet above the lock paving and 600 feet below. On the opposite side the whole front of 800 feet owned by the Government is protected either by riprap or paving. In places this stone is several feet in depth, but generally it is from 1 to 2 feet. The surface covered amounts to 124,331 square feet. Not counting the expense of blasting, which has been accounted for under the head of excavation, the cost of this work was $2,348.38.

Paving.—The paving behind and above the lock is 301 feet in length and 48 feet wide at upper end and as far down as the middle of the lock; from this point to lower end it widens slightly, the slope of bank being somewhat less than above. The paving stones were quarried from backing stone unused in the original construction, and also from those taken from lock at time of reduction of walls and which were not required in foundation of dam. As the stone was not regular in grain, considerable cutting was necessary in order to make a workmanlike job of the paving. The pavers are about 10 inches thick and vary in length from 18 to 36 inches. On the opposite side the paving reaches 26 feet above abutment and over 200 feet below, and it is 130 feet wide at upper end, running to a point at lower end. The paved space covers 50.392 square feet of ground, and is well laid on a bed of broken stone varying in thickness from 1 to 3 feet. The cost of this work, which does not include original price of stone delivered as backing, was $4,470.40.

Retaining walls.—The walls with which the old cribs below and above lock were replaced were made of stone remaining after completion of masonry, quarried out and roughly dressed and laid in cement. They are generally 1 foot in thickness at top and are backed up with broken stone. At points where the rock was badly shattered its removal to considerable depth was necessary, and the wall was carried much deeper than its general average, which is only a few feet; they extend 233 feet below and 379 feet above lock, and form a toe against which the riprap of the bank is placed. The walls cost $1,077.60, being about 44 cents per square foot face, which includes the labor, quarrying, and cutting stone from the backing on hand and laying same, and cement.

Roads.—Roads leading from low water to top of bank, and of easy grade, were constructed on each side of river below dam. They are 10 to 15 feet wide and are paved and drained. The total length of the two is over 600 feet. The earth removed in grading was largely used in puddling cofferdams, so that it may be said that the excavation practically cost nothing. The cost properly chargeable was $380.

Grading grounds.—The land behind lock was made unsightly by a washout of considerable width and depth, and numerous smaller ones cut the grounds at various points. These were all filled with earth, and other inequalities reduced until the grounds now present a uniform grade and neat appearance. The quantity of material handled was 1,112 cubic yards, and it cost $278.50.

Lock houses, etc.—An addition was built to the office for one of the lock houses and a new house was built for the other. The former has four rooms, with cellar, pantry, porches, etc., and the latter has seven rooms, larger cellar, and other conveniences. Suitable outbuildings were also constructed, and a building for use as a blacksmith shop and tool house. The total cost was $3,151.19.

FIXED DAM AND ABUTMENT.

DAM.

General statement.—As has been stated, the original plan was for a stationary dam made of timber cribs filled with broken stone. The upstream part was to be founded on piles driven to bed rock and the downstream of cribs sunk to rock, the material being dredged out for the purpose. About 90 feet of dam next the abutment was nearly completed, and 30 feet entirely decked over and completed, and the piles and sheeting for 110 feet next lock had been driven and partly capped before the plan was changed. Contracts had been made for the entire timber for the dam, amounting to 578,558 feet B. M., and costing $11,255.45.

Excavation.—The end of the dam next abutment was built in a cut made in the bank inside of low-water mark. The end next lock was also started in a cut made through a dump of waste material from the lock. The total amount of excavation made from these two sections was 9,044 cubic yards, and cost $1,736.56.

Pile driving.—The pile driving for the foundation was done with the old-style pile drivers and engine, and piles were placed 10 feet between centers, both across and with the direction of the river. Along the upstream side of the line of the dam were driven three tiers of 3-inch sheet piles; in all, 1,998 linear feet of piles and 26,880 feet B. M. sheet piles were driven, costing $1,483.40.

Timber work.—The piles were capped with flatted timbers 12 inches thick at about low-water line, and on these the cribs of the dam were built, and they were sheathed on the upstream side. There were 69,865 feet B. M. timber placed, at a cost of $2,319.74.

Filling and backing.—The cribs were filled with stone as fast as completed. The quantity used was 2,123 cubic yards, the stone being taken from waste dump outside lock coffer; also 435 yards of gravel, etc., were used to back up the completed part of dam. The cost of this work was $983.60, counting nothing for the excavation of stone from lock site.

ABUTMENT.

Description.—After the lock was completed, and previous to the change of plan from fixed to movable dam, the abutment for the proposed dam was put in. It was situated opposite the upper end of lock and was 350 feet from the river wall of same. It was 100 feet long and had a wing from upper end reaching into bank a distance of 50 feet from its face.

Excavation.—In order to get sufficient length of spillway for the dam, the abutment was located well in the bank. This necessitated considerable excavation, as the bank is very high and rather inclined to cave in and wash, thus requiring a long, flat slope. The material was largely sand and clay and was quite easily removed. The quantity taken out was 15,359 cubic yards, and cost $2,490.27.

Foundation.—After the site was excavated and the bank sloped back so that it was safe to work, piles were driven at intervals of 3½ feet between centers; these were cut off at about lower pool level and capped; between these caps concrete was placed, and on top was bolted a heavy squared-timber platform. The upper face of abutment and wing foundation were protected by heavy sheet piles driven to bed rock. Below the site of dam the foundation of abutment was protected from undermining by a crib sunk just outside and filled with stone. The foundation contained 3,900 linear feet of piles and 36,000 feet B. M. of timber, and cost $1,560.83. The protection contained 7,200 feet B. M. timber and 78 cubic yards broken stone, and cost $243.

Masonry.—Like the lock, the abutment was laid in Rosendale cement, the mortar being mixed in the same proportions as that given for lock. The exposed faces of the wall were pitch face stone. The coping was crandalled, face and top, by hired labor, from the stone on hand which had been obtained in the lock contract. This extra cutting for 65 cubic yards cost $565.10. The abutment contained 1,833 cubic yards, and cost $12,281.10, including stone, labor, cement, and sand.

Embankment.—The fact that the bank required a flat slope to prevent its caving in during the progress of the work on the foundation masonry rendered it necessary to fill behind the abutment when completed. This fill was made almost wholly of broken stone blasted out of the lower approach to lock and transferred across the river in dump cars and hauled to top of bank with an engine, from which point they were taken to the point at which the material was required. A considerable quantity of clay puddle was used next the wing wall to guard against leakage. The quantity of material placed behind abutment was 2,750 cubic yards, and its cost was $1,180.

III. MISCELLANEOUS—ALTERATIONS CAUSED BY CHANGE OF PLANS.

LOCK.

Upper sills, etc.—Upon the change of plan of dam it became necessary to lower the upper miter wall and all the masonry in head of lock to accommodate navigation at times when the dam was being raised and previous to the raising of the pool. In order to place the upper sills sufficiently low for this purpose, all masonry was removed except the bottom course, and the sill course was reset at the new level and the sills bolted to bed rock. The cutting out of this headbay masonry left the walls with an uneven face, which was smoothed up as well as possible with tools. Iron hollow quoins were put in so as to give the gates as even and tight bearings as practicable. At some places new stones were cut and fitted into the faces of the walls to improve their appearance, it being impossible to cut through the walls smoothly at all points. The head wall and sill and journal boxes of the adjustable dam in head of lock were also lowered and the sill and trestles reset.

Lowering walls.—The height of the stationary dam was to have been 18 feet above lower miter sill, and the lock had a guard of 10 feet. The movable dam was to be several feet lower, and required but little guard, and it was decided, therefore, to cut down the lock walls about 7 feet, and thus obtain stone with which to build part of the foundation for movable dam. While this necessitated the removal of all the lock irons, ladders, wickets, etc., and the resetting of the coping, yet it was much cheaper than purchasing new stone for the dam. Five courses, including coping, were removed, and then the coping stones were reset. The stone taken out of land wall and cross walls was hoisted to top of bank and piled away; that removed from river wall was first piled on the waste dump outside the lock and repiled on the wall itself after coping had been put on; from there it was transferred to points where required, for use later on. The amount of stone removed was 2,202.11 cubic yards, 395.27 of which, nearly all coping, was reset.

Gates, wickets, etc.—The lowering of lock walls also made it necessary to cut the lower gates down, which was done, the irons being shortened and welded in the shop on the works. The gates were, however, replaced by new ones before the lock was put into operation, as their age (seven years) and the fact that they had been out of water much of the time caused decay, which rendered them unsafe. The upper gates were too low after the miter wall was reduced, and their design had to be changed to one permitting the use of the filling valves. The irons, however, were utilized in building the new gates.

The upper wickets were removed, the culverts having been destroyed in cutting down the breast wall. The lower wicket shafts were cut off to the correct length and used in their proper places. The gate anchorages, ladders, etc., were reset and utilized.

Cost.—Not counting the cost of the new gates and irons, the total expense of these changes for the lock alone, including tearing out, removing, and piling away, resetting coping, smoothing wall, and removing upper and cutting down lower gates, was $4,865.37.

AT OTHER POINTS.

Lowering upper lock approach.—It was necessary to bring the upper approach to lock down to the new level of the upper miter sill, and this required the removal of a large quantity of solid rock and not a little overlying deposit which had accumulated. The excavation was about 70 feet in width and 400 feet long, and ranged in depth from 2 to 8 feet. Seven thousand nine hundred and twenty cubic yards of rock and 3,800 yards of earth were excavated, at a cost of $7,096.

Excavation behind lock.—The lowering of the land wall necessitated the removal of that part of the embankment adjoining the part of wall taken out and the grading of a new slope back to top of bank. This excavation contained 1,112 cubic yards, and cost $248.38.

Removing waste dump.—Previous to the change of plan, it was proposed to utilize most of the stone blasted from lock site and approaches for filling cribs of stationary dam, and this material was wasted in the river outside of and below lock coffer, where it could be easily gotten. The change of plan, however, necessitated its removal, as it was located directly in the proposed pass channel; this was mostly done by dredging to a considerable depth and removing the material on barges, although a considerable quantity was removed by men. The quantity excavated by dredge was 55,155 cubic yards, at a cost of $5,878, and by men 11,641 cubic yards, at a cost of $3,882.30. These amounts included large quantities of sand, which washed in the way on each rise and greatly increased the cost and amount of material excavated.

Removing old abutment.—The abutment for fixed dam was opposite upper end of lock, and it was necessary to tear it down to secure stone for the construction of weir and new abutment masonry. The stone was partly removed to yard on top of bank and partly taken direct to weir to be laid. That taken to yard was recut into coping and pitch-face stone. The cost of removal was $908.44.

TEMPORARY BUILDINGS, BOATS, ETC.

Rebuilding dredge hull.—The dredges used on this work belonged on Kentucky River; one of them carried the machinery of a former dredge on a new hull, built on Kentucky River, and a part of the expense charged to Big Sandy. The amount of bills paid by the latter for timber, bolts, iron, oakum, etc., was $799.71.

Construction of needle boat.—On account of the high banks at this lock it was not deemed advisable to provide a storehouse in the yard for the needles, but rather prepare a boat suitable for their storage and care. This boat was also fitted out for assisting in the maneuvers of the needles. The hull is 14 feet wide and 48 feet long; it is provided with boiler and engine, which have been long in use on the work, and capstan; also overhead tracks and trolleys for convenience in handling needles. A tin roof covers the entire hull and projects 6 feet over one end. The cost of the boat, exclusive of the old rails used, and boiler and engine, was $671.37.

Barges and boats.—Three old barges were purchased for use in connection with dredge. After one season's use it was necessary to recalk and repair them and put in new pieces in decks and bottoms.

Two or three push boats were purchased from time to time, and as they became old it was necessary to put on new bottoms and make other repairs. The first cost of the barges, boats, and skiffs was $1,024, and the repairs of various kinds amounted to $165.30.

Derricks.—All the derricks used were built on the works; the masts and booms were of pine or popular, purchased in the neighborhood, and dressed to such shape as desired. There were built during the entire construction 17 good-sized derricks besides several smaller ones for temporary use. The cost of the derricks, including guy lines, irons, sheaves, crabs, and rigging of wire and manila rope and blocks, was $2,678.29. To this may be added the cost of traveling derrick, $1,342.82, making a total for derricks and rigging of $4,021.11.

Temporary buildings.—It was necessary to build an office, cement sheds, tool houses, magazines, blacksmith shops, and engine and boiler houses. The office was built by contract for $400, and later utilized as part of a lock hand's dwelling. The other buildings were built by hired labor of rough lumber sawed at local mills, and the entire cost was $1,150.

Miscellaneous.—There were built on the works numerous small articles of various kinds, and also many more important appliances, among which were 16 tramcars, 32 dump-car beds, 3 large pile drivers, 12 small pile drivers, 1 concrete mixer, and 14 dump boxes.

IV. DETAILED STATEMENTS OF COST.

Lock.

Cofferdam:		
Piles, 1,860 linear feet	$148.80	
Timber and lumber, 61,253 feet B. M	793.56	
Bolts, spikes, etc., 4,482 pounds	166.63	
Clay filling, 1,365 cubic yards	764.40	
General work	874.21	
		$2,747.60

Excavation:		
Solid rock, 14,695 cubic yards	$16,533.45	
Loose rock, 200 cubic yards	350.00	
Earth, 7,334 cubic yards	1,691.00	
		$18,574.45
Concrete:		
Stone, 53 cubic yards	63.75	
Cement, 63 barrels	111.79	
Sand, 24 cubic yards	6.60	
Labor	94.65	
		276.79
Masonry:		
Stone, 8,579 cubic yards	49,309.67	
Cement, 4,037 barrels	7,365.06	
Sand, 1,176 cubic yards	200.00	
Labor	11,977.71	
Miscellaneous	2,739.12	
		71,591.56
Miter sills:		
Timber, 5,568 feet B. M	139.20	
Bolts, 912 pounds	77.93	
Lead, 347 pounds	19.17	
Labor and miscellaneous	329.14	
		565.44
First gates:		
Timber, 45,176 feet B. M	1,581.16	
Iron, 63,310 pounds	3,165.50	
Labor	2,841.30	
Miscellaneous	562.12	
		8,150.08
Second gates:		
Timber, 43,893 feet B. M	1,190.93	
Iron, 13,600 pounds	612.73	
Labor	1,019.50	
Miscellaneous	281.60	
		3,104.76
Temporary dams:		
Timber, 16,108 feet B. M	299.49	
Iron, 36,154 pounds	1,487.56	
Labor and miscellaneous	223.18	
		2,010.23
General:		
Embankment, 3,300 cubic yards	1,896.30	
Valves	1,020.20	
Plant	4,411.99	
Buildings	806.40	
Repairs	426.00	
Miscellaneous	4,789.96	
		13,350.85
Total		120,371.76

Movable dam.

Cofferdams:		
Piles, 7,420 linear feet	$1,360.32	
Timber and lumber, 180,845 feet B. M	3,670.09	
Bolts, spikes, etc., 7,250 pounds	251.75	
Clay filling, 2,936 cubic yards	1,178.30	
General work	3,456.95	
		$9,917.41
Excavation:		
Earth, etc., 13,910 cubic yards	3,010.70	
Loose rock, 280 cubic yards	132.00	
Solid rock, 60 cubic yards	58.00	
		3,200.70
Concrete:		
Stone, 1,578 cubic yards	1,386.08	
Cement, 2,762 barrels	4,557.30	
Sand, 706 cubic yards	157.08	
Labor, etc	2,035.32	
		8,135.78

Masonry:		
Stone, 3,135 cubic yards	$24,294.41	
Cement, 1,094 barrels	1,770.60	
Sand, 437 cubic yards	92.10	
Labor, etc	3,332.91	
		$29,490.02
Sills and fixed ironwork:		
Timber, 11,116 feet B. M	532.28	
Wrought iron, 42,160 pounds	1,648.40	
Cast iron, 74,413 pounds	2,185.18	
Labor	1,193.61	
		5,559.47
Trestles, etc.:		
Steel, 71,456 pounds	3,344.64	
Labor, etc	480.00	
		3,824.64
Needles:		
Timber, 27,094 feet B. M	812.82	
Iron	347.60	
Labor, etc	193.40	
		1,353.82
Operating mechanism, etc.:		
Needle boat	671.37	
Crabs	200.00	
Chains	450.00	
Boom	1,231.83	
		2,553.20
General:		
Miscellaneous	7,327.76	
Plant	4,888.24	
		12,216.00
Total		76,251.04

Approaches, protection works, etc.

Lock approaches:		
Solid rock, 15,920 cubic yards	$14,009.60	
Loose rock, 4,050 cubic yards	1,944.10	
Earth, 15,160 cubic yards	2,250.60	
Coal, 7,000 bushels	215.40	
		$18,419.70
Cribs:		
Timber and lumber, 64,667 feet B. M	1,094.78	
Piles, 1,800 linear feet	251.00	
Iron, 2,957 pounds	115.00	
Stone, 714 cubic yards	565.20	
		2,025.98
Protection works:		
Riprap, 124,331 square feet	2,348.38	
Paving, 50,392 square feet	4,470.40	
Retaining walls, 2,450 square feet	1,077.60	
		7,896.38
Buildings and grounds:		
Land	3,781.15	
Grading grounds	278.50	
Buildings	3,151.19	
		7,210.84
Total		35,552.90

Fixed dam and abutment.

Fixed dam:		
Excavation, 9,044 cubic yards	$1,736.56	
Piles, 1,998 linear feet	677.00	
Timber and lumber, 96,745 feet B. M	3,126.14	
Filling and backing, 2,558 cubic yards	938.60	
Miscellaneous	854.27	
		$7,332.57

Abutment:		
Excavation, 15,359 cubic yards	$2,490.27	
Piles, 3,900 linear feet	618.83	
Timber and lumber, 43,200 feet B. M	1,161.00	
Filling, 78 cubic yards	73.00	
Masonry, 1,833 cubic yards	12,846.20	
Embankment, 2,750 cubic yards	1,180.00	
Miscellaneous	1,032.20	
		$19,401.50
Total		26,734.07

Miscellaneous.

Reducing lock walls, etc	$4,865.37	
Removing waste dump, etc	9,760.30	
Removing old abutment	908.44	
Building roads	380.00	
Rebuilding and repairing dredge	1,119.11	
Barges, boats, etc	1,189.30	
Temporary buildings	1,150.00	
General work	9,890.90	
		$29,263.42

RECAPITULATION.

Lock	$120,371.76
Movable dam, operating mechanism, etc	76,251.04
Approaches, protection works, etc	35,552.90
Fixed dam and abutment	26,734.07
Miscellaneous	29,263.42
Engineering, superintendence, etc	40,440.40
Office expenses at Cincinnati	20,542.23
Total	349,155.82

V. MANEUVERS.

The various operations required in maneuvering the needle dam are as follows:

1. Raising the trestles.
2. Placing the needles.
3. Removing the needles.
4. Lowering the trestles.

An explanation of these maneuvers will now be given, assuming that the various parts of the dam are understood from the preceding description.

1. Raising the trestles.—The raising of the trestles may be done in two ways: (1) by a crab located on pier for weir, and on lock wall for pass; and (2) by needle boat anchored above, and raising chain passed over sheave and leading at right angles to dam to drum of engine. Up to the present time the latter method has been but little employed, as the arrangements were not perfected until within a few days of this writing, but it bids fair to be successful.

By the first method the chain is wound in by two men at stationary crab on masonry; the chain passes over a pocket wheel and drops through a hole in the masonry into the recess provided for pass trestles in pier and into the manhole of the discharging culverts in lock; as the chain is wound in it brings up the first trestle and starts others; when the first trestle is nearly upright the attendant standing on the masonry lifts the end of the floor section, which lies on the chain a few inches, and this movement depresses one end of the pawl and raises the opposite end out of the ratchet on chain wheel. When the pawl and ratchet are separated rigid connection between the trestles and chain ceases, and the attendant can handle the trestle at will without the crabmen stopping the winding in. The attendant hooks the floor section into the place provided for it on the masonry and fastens it with a latch moved by the foot, and then standing on the bridge thus formed, he brings the escape or connecting bar into place with a hook made for the purpose and turns the jack post, which is fastened to the masonry to lock it. By this time the floor of the second trestle comes within easy reach, and the attendant repeats the operation of slightly raising the free end, and thus releases it from the chain and hooks it into the first trestle and latches it with the foot latch. By a repetition of these maneuvers the trestles are all brought upright and connected with each other. When the last trestle has been raised a rolling bridge is drawn out from a recess in the masonry and connected with it, and thus a foot bridge is completed from one part of the masonry to another. It will be observed that by winding in the length of chain at which the trestles are spaced each trestle is brought up. After the first one, which has a sufficient length of chain to reach from top to bottom of masonry plus the distance from masonry to head of trestle when down, the length is generaly 4 feet, i. e., the trestles themselves are 4 feet between centers, and by allowing 8 feet of chain to each it is only necessary to wind in 4 feet of this to properly bring the trestle to position.

The time taken to raise either pass or weir trestles is about forty minutes.

2. Placing the needles.—The pass needles are stored on a boat and are so constructed that they lie perfectly flat on each other when piled, so as to prevent warping and save space. Immediately over the piles of needles, on each side of the boat, is a suspended track on which travels a trolley. The needles are all stored with their heads in one direction, toward the dam. At about the center of weight of each needle is a ring. The trolley has a sheave over which a chain having a hook at one end passes; by placing this hook in the ring of needle and pulling down on free end of chain the needle will be raised from pile; near the hook is a catch or claw on the chain, the purpose of which is to hold the bight of that part of chain pulled down in raising needle. Thus the needle after being raised remains suspended, and by pushing it the trolley rolls along the track overhead and carries it out to bow of boat, the free end of chain lying idle on the needle. The boat is placed so that its bow is only a few feet upstream from the trestles, and when the needle is brought to end of track its head projects over onto footbridge; here it is grasped by the attendant stationed on trestles and placed on the support bar alongside the last needle put in. The trolley track projects over hull of boat several feet, so that when the head of the needle is in its proper place on the trestles the butt or foot is just at bow. When all is ready a quick jerk on free end of trolley chain releases it from the claw, and the weight of the needle pulls the chain over the sheave. When the needle strikes the water the current carries it against the sill, the force of the blow being lessened by the men holding the free end of the chain, thus allowing it to come to its place gradually. When the strain is off the chain the hook drops out of the ring and the ring drops into a recess in needle made for it. A stage plank projects about 15 feet from one side of the boat parallel with the dam, so that it is possible to place about 30 feet of dam without moving boat, by allowing the needles to float out to position. As the placing of the needles progresses a swift current develops around the wall so constructed, and it was found necessary to hold back in order to prevent the needle being placed from moving along the sill. In the latest maneuvers the force of the current has been broken by a screen, with great satisfaction.

After the pass needles have been placed those of the weir are put in. When the water is warm an attendant stands on the masonry above the sill and places the needles at bottom, while another attendant holds the head. If the water is too deep or cold for the application of this method the needle boat may be used or the attendant may stand on a light boat above and guide the needles into place, and by holding back, break the force of the blow when they strike the sill. The greatest speed yet attained is one needle or 1 foot of dam per minute on pass, and the whole weir in fifteen minutes after the needles have been laid on the footbridge ready to be placed by two men on masonry and two on bridge working from opposite ends of dam. The placing of the pass needles can not be done more rapidly with present plans, but a new method is being developed which, if successful, will materially shorten the time of placing, and I think it safe to predict that both pass and weir can be placed after the needles have been gotten ready within less time than it now requires for the weir alone.

3. Removing the needles.—When a rise approaches, the wickets in the lock are opened, and when they fail to keep the pool down to its normal level alternate needles are "stood out"—that is, the heads of alternate needles are pushed upstream and a pin or stick placed between them and the support bar; this permits the escape of a great quantity of water. When this fails to keep the pool down the weir needles thus standing out may be entirely moved, or if indications point to a considerable rise, all the weir needles may be removed by the method explained further on. A continuation of the rise may necessitate the removal of all the needles standing out in the pass or even the whole of the pass.

The device used for pushing out the head of the weir needles is a jack devised by the lock master, T. J. Snyder. With it one man can rapidly stand the needles out. On the pass a larger jack on the same plan would answer, but so far we have used a line attached to the head of needle and running to a capstan on needle boat which lies against the dam.

The removal of the needles is now to be explained. Near the top of each needle is a countersunk handle for use only in removing the needle; a chain much longer than the length of dam is passed along the upstream side of the needles and connected by hooks with these handles; there is considerable length of slack chain between each pair of handles; the end of the chain is fastened to a long line leading to the engine on the needle boat, which is anchored well upstream. By starting the engine the first needle is pulled away from its support at top, and when it has traveled the length of slack chain leading to the next the second is started, and so on until all are removed and are afloat. This maneuver is very rapid, the time required being simply that which is necessary to wind the rope on the drum of the engine. The boat is anchored in such direction that the needles float into the quiet water above the unremoved portion of dam.

The original intention was to adopt the escapement method of removing the needles, and this can still be used if desired, but it was found that the wide needles would be greatly damaged, particularly on weir, by allowing them to fall downstream. The method employed is more rapid and less destructive to the needles, and in every way more satisfactory.

After the needles have all been removed they are drawn onto the boat by suitable contrivances at the opposite end from that which was used in placing them, and piled away by use of trolley; this leaves the heads in the right direction when it is again desired to place them. Later on it is proposed to perfect a means of taking the needles directly out of the water and placing them in the dam, and thus they will only be piled away when there is a continued season of high water and during the winter.

4. *Lowering the trestles.*—To lower the trestles, the last one raised is the first to start down. The attendant stands on the footbridge and first unhooks the rolling bridge and pushes it back into its recess. He then disconnects the escape bar of the last trestle and throws it around against its trestle and then unhooks the floor section, which falls on the chain and rests there, and gives it a push, the man at crab at the same time slacking on brake so as to unwind the chain. When the chain has run out about 4 feet, the attendant throws the pawl of the standing trestle into its ratchet, and thus the descending trestle is stopped. The escape bar and floor section of this trestle are then released and the weight of the trestle, already under way, pulls it toward itself when the chain wheel of crab is allowed to turn, thus paying out more chain. The operation of throwing the pawl in the ratchet is again performed when the chain has gone as far as desired. A repetition of these maneuvers brings all trestles to their beds with their floor sections resting on top of them. In this manner four or five trestles are descending simultaneously, and as fast as one comes to rest another is attached. The time required for lowering either pass or weir is about twenty minutes.

By the addition of a new chain it has been made possible to lower each trestle separately, if desirable, during a heavy run of drift or for other reasons. In this case the chain can be spaced beforehand, and the operation of lowering will consist simply of releasing the connection between trestles and allowing them to fall, as is done with the old-style trestles, or they can be lowered with crab, the pawl of the standing trestle not being thrown into the ratchet until the trestle being lowered comes to rest. In this case a line pulling from the opposite end of dam would be required to start the trestle downward, but a better solution would be to throw in the pawl a little before the descending trestle came to rest. Its weight would then start the next trestle when released.

While the maneuvers have all been fairly satisfactory so far, yet the dam has not been operated under especially difficult conditions, and it is too early to predict entire success under all circumstances which may occur. A rapidly rising river filled with drift arriving at night in snow or rain might complicate matters considerably and change an apparent success into a certain failure without warning. All precautions possible, except the construction of telephone lines owned and operated by the Government, have been taken to provide against surprise, and results are now to be awaited with anxiety and difficulties met with courage and intelligence.

Probable modifications.—It has already been stated that new ideas for the placing of needles are under consideration. The employment of steam on the needle boat for removing the needles has been more than satisfactory, and has reduced the time of this operation to almost nothing. It is proposed to employ it in all the other operations, raising and lowering trestles, placing needles in the dam, and storing them away on the boat. The details of the new ideas have not all been worked out, and none of them, except the removal of needles and raising trestles, have been applied, and these to only a limited extent. The results of these experiments and a description of the maneuvers as modified will be given in a subsequent report.

Very respectfully, your obedient servant,

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

C.

Report of Mr. D. A. Watt, civil engineer, upon the calculations for the trestles and needles of the dam in Big Sandy River, near Louisa, Ky.

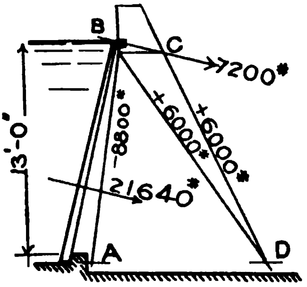
UNITED STATES ENGINEER OFFICE,
Cincinnati, Ohio, June 30, 1897.

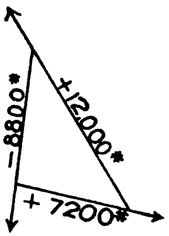
MAJOR: Supplementary to the report of Mr. B. F. Thomas, assistant engineer, in local charge of the work on the Big Sandy River at Louisa, Ky., I have the honor to submit herewith an illustration of the calculations made by me for the trestles and needles of the movable dam in that locality:

Pass trestles.—The precise outline of the trestles had to be determined by trial, as it was required that each trestle should lie down inside instead of upon the preceding one. The height was of course determined by the lift, while the width of base was made about sixty-six one hundredths of the height, in accordance with similar examples in France. The inclinations of the main members having thus been decided, the strains in them were found to be as follows:

The maximum head occurs with the water at pool level above and no water below, and = 13 feet.

The pressure on each needle 12 inches wide = 1′ — o″ × 13.3′ × 62.5 pounds × 6.5′ = 5,410 pounds.





Total pressure on one bay 4 feet wide = 21,640 pounds. One-third of this being supported by the escape bar, we have the pressure at B = say 7,200 pounds per trestle.

The strains in the main members may then be found graphically or by analysis, assuming that the compression on the downstream side is equally distributed by the gussets into the two lower channels. We thus find: Tension in AB, 8,800 pounds; vertical upward pull at A, 8,700 pounds; compression in BD and CD, 6,000 pounds each.

Each of these members is a 4″—7.25# channel, this size being adopted as most suitable for the purposes of the shop and of the field, and as possessing a thickness of metal which would afford a margin for deterioration by rust. All braces and connections were made heavier than usual with this latter object in view.

Tension per square inch in AB, net section, $= \frac{8,800}{1.63} = 5,400$ pounds, corresponding to a factor of safety of about 11.1.

Compression per square inch in BD or CD, $= \frac{6,000}{2.13} = 2,800$ pounds.

Ultimate strength per square inch, deduced from Gordon's formula, pin and square bearing columns, = 24,600 pounds.

BD and CD thus have a factor of safety of about 8.8.

The radius of gyration is here taken at right angles to the web. If it be taken parallel to it a result will be obtained practically similar, as the column length is reduced by the cross braces.

The channels are also subject to a bending moment when being raised, due to deposits of sand, etc. To ascertain the effect of this under ordinary circumstances, a cube of deposit was assumed along the parts of the trestle to a depth of 9 inches, which gives a total weight of 35 pounds per linear foot, including the iron work. The greatest distance from the shoe pin to the chain being 16.5 feet, we have:

$$\text{Moment} = \frac{35\# \times 16.5' \times 16.5' \times 12}{8} = 14,200 \text{ inch pounds.}$$

And if s = the extreme fiber stress per square inch, we have from the usual formula for the flexure of beams:

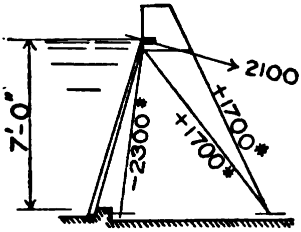
$$s = \frac{Mc}{I} = \frac{14{,}200 \times 2''}{4.6} = 6{,}200 \text{ pounds.}$$

Adding for the upper flange 200 pounds per square inch for the compression from the hoisting chain, we have:

Maximum flange stress per square inch = 6,400 pounds,

corresponding to a factor of safety of about 9.4.

Weir trestles.—The strains in the weir trestles, under assumptions similar to the foregoing, were found to be as indicated on the accompanying diagram.



The same sizes of matorial and similar outlines were used as on the trestles of the pass, for the purpose of simplifying the work.

The experience which has been obtained thus far with these trestles has shown them to possess stiffness and freedom from vibration to a noteworthy degree.

Needles.—The needles are all of white pine and are 12 inches in width. Those of the pass were designed for an extreme fiber stress of 1,200 pounds per square inch with the water at pool level and no water below. This somewhat high strain was adopted in order to reduce the size of the needles as far as practicable, as they are of dimensions larger than have been used heretofore, and it was anticipated that there would be difficulty in handling them.

The maximum moment under these conditions occurs at a vertical distance $d = h \div \sqrt{3}$ from the surface, if h = the depth of water, or in this case = 13 feet; d therefore = 7.51 feet.

$$\text{Moment} = (1{,}800 \text{ pounds} \times 7.7' \times 12) - (1.0' \times 7.7' \times 62.5\# \times \frac{7.51'}{2} \times \frac{7.7'}{3} \times 12) = 110{,}800 \text{ inch pounds.}$$

Then from the usual formula, if I = moment of inertia,

$$I = \frac{M}{s} \times \frac{t}{2} \text{ and } = \frac{bt^3}{12},$$

t being the thickness required at the point of maximum moment.

Combining and reducing we find $t = 6.80$ inches, which dimension was adopted.

The strain assumed for the weir needles was a little over 900 pounds per square inch, as they are more liable to deterioration from frequent handling.

Respectfully submitted.

D. A. WATT, *Civil Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

D.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: In response to your letter of the 11th instant, I have the honor to forward herewith the estimates requested of cost of lock and needle dam at Louisa if the same had been built under favorable conditions. It is believed that the estimate is sufficiently liberal, and that if built under the contract system, or under a system without long delays, the figures will not be exceeded.

Estimate of probable cost of lock and needle dam similar to the one in Big Sandy River, West Virginia and Kentucky, at Louisa, Ky.

1. LOCK.

	Cubic yards.	Price per yard.	Amount.
Special stone	636	$15.00	$9,540.00
Dressed face stone	1,545	7.50	11,587.50
Pitch face	995	6.50	6,467.50
Squared stone	824	5.50	4,532.00
Backing	6,000	4.50	27,000.00
Total	10,000	....	59,127.00
Laying 10,000 cubic yards stone, at $2.25			22,500.00
Gates, valves, temporary dams, etc			7,500.00
Cofferdam			2,750.00
Lock above foundation			91,877.00
Rock excavation, 7,000 cubic yards, at $1			7,000.00
Total			98,877.00
Contingencies and engineering			9,887.70
Total cost of lock			108,764.70

NOTE.—This estimate is made on the supposition that the original plan was for needle dam, in which case the lock would have stood further from bank and thereby increase the quantity of masonry and decrease the quantity of rock excavated.

2. NEEDLE DAM.

	Cubic yards.	Price per yard.	Amount.
Special stone	450	$15.00	$6,750.00
Pitch face	1,300	6.00	8,450.00
Backing	1,385	4.50	6,232.50
Total	3,135	....	21,432.50
Laying 3,135 cubic yards stone, at $3			9,405.00
Concrete, 1,578 cubic yards, at $5.25			8,284.50
Cofferdams			8,000.00
Excavation, 6,000 cubic yards, at 50 cents			3,000.00
Timber sills, 12,000 feet B. M., at $45			540.00
Fixed iron work:			
42,000 pounds wrought, at 5 cents			2,100.00
75,000 pounds cast, at 4½ cents			3,375.00
Trestles, 72,000 pounds steel, at 5 cents			3,600.00
Needles, 150 for weir, at $3.50			525.00
Needles, 150 for pass, at $5			750.00
Needle boat (with engine)			1,500.00
Operating crabs and chains			500.00
Total			63,012.00
Contingencies and engineering			6,301.20
Total cost of dam			69,313.20

MISCELLANEOUS.

Embankment behind lock and abutment, 5,000 cubic yards, at 30 cents	$1,500.00
Paving behind lock and abutment, 3,000 square yards, at $1.50	4,500.00
Riprap on banks, 6,000 square yards, at 50 cents	3,000.00
Retaining walls above and below lock, 2,500 square feet, at 50 cents	1,250.00
Lock buildings	3,000.00
General work	5,000.00
Total	18,250.00
Contingencies	1,825.00
Total miscellaneous	20,075.00

RECAPITULATION.

Lock	$108,764.70
Dam	69,313.20
Miscellaneous	20,075.00
Total	198,152.90

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

2

B.F. Thomas, Ass't. E

Drawn by John M.G.W

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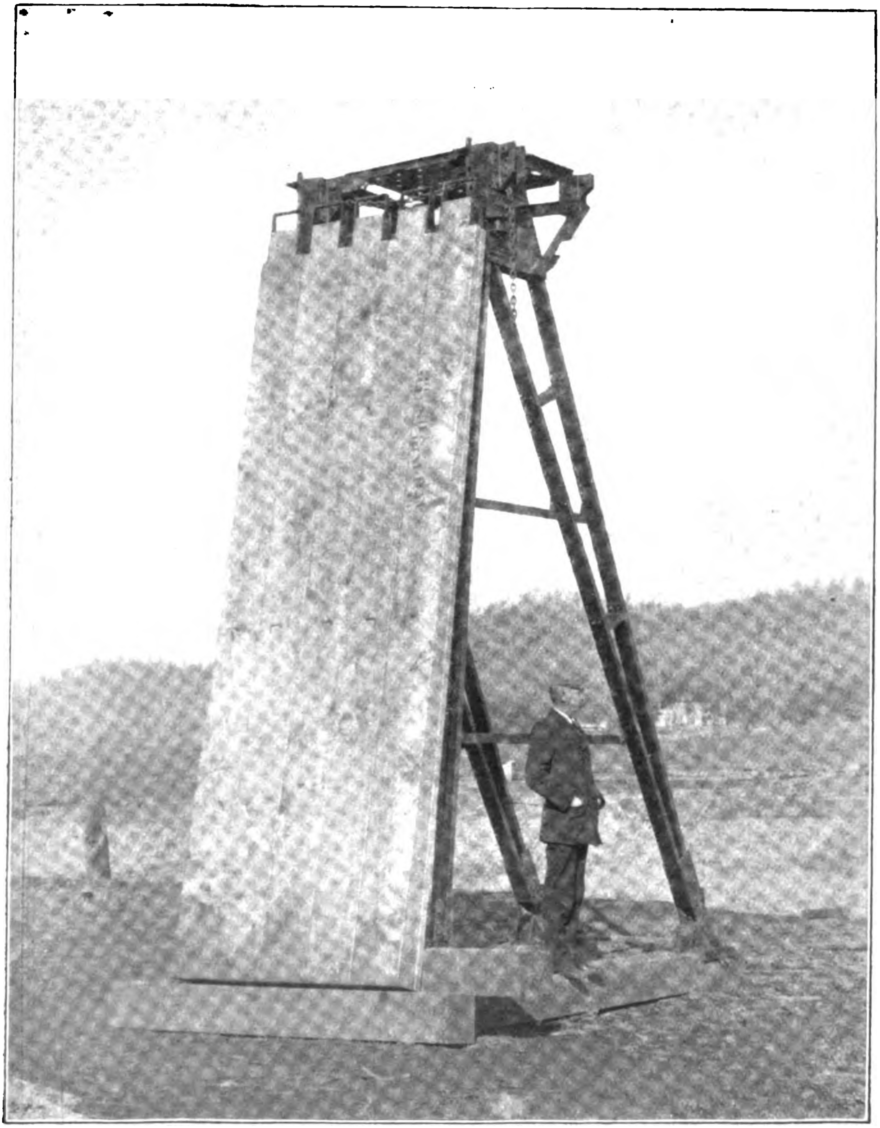
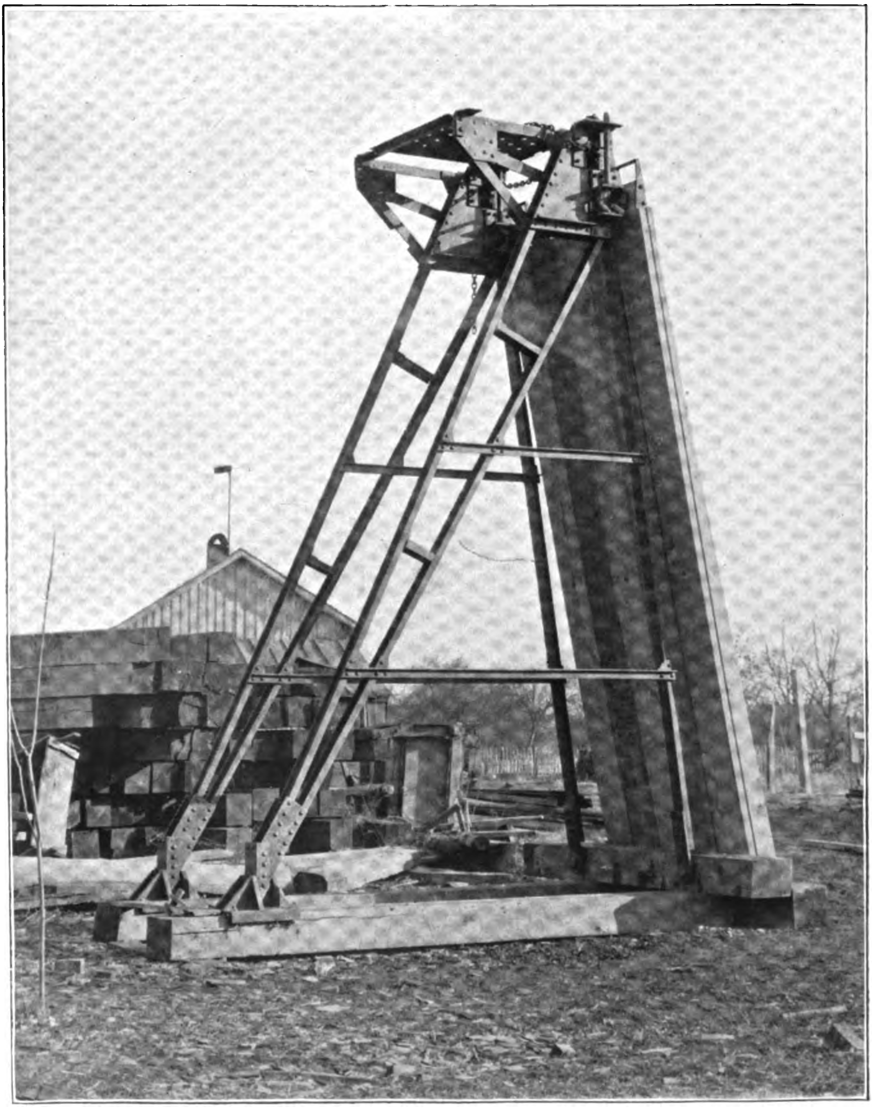
3

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



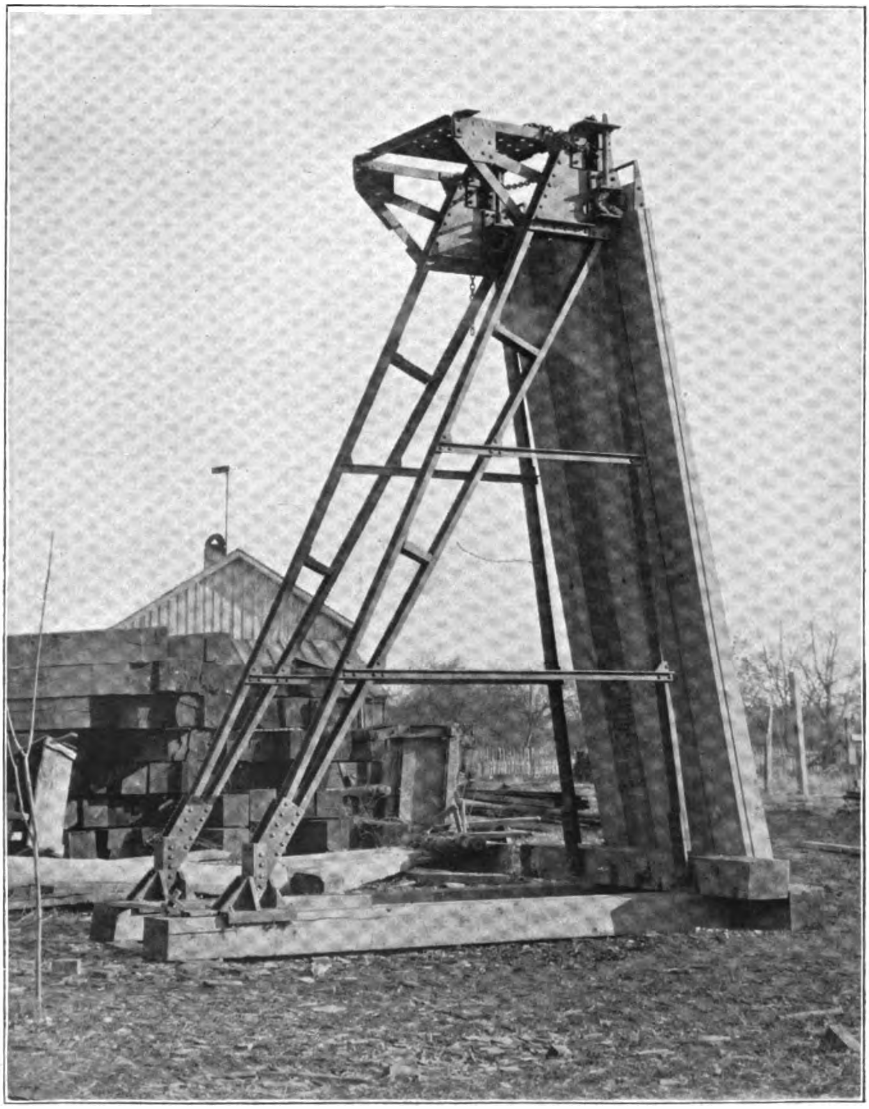
No. 1.—VIEW OF TWO PASS TRESTLES AND FIVE NEEDLES SET UP IN POSITION; UPSTREAM SIDE.
The trestles are lowered to the left.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



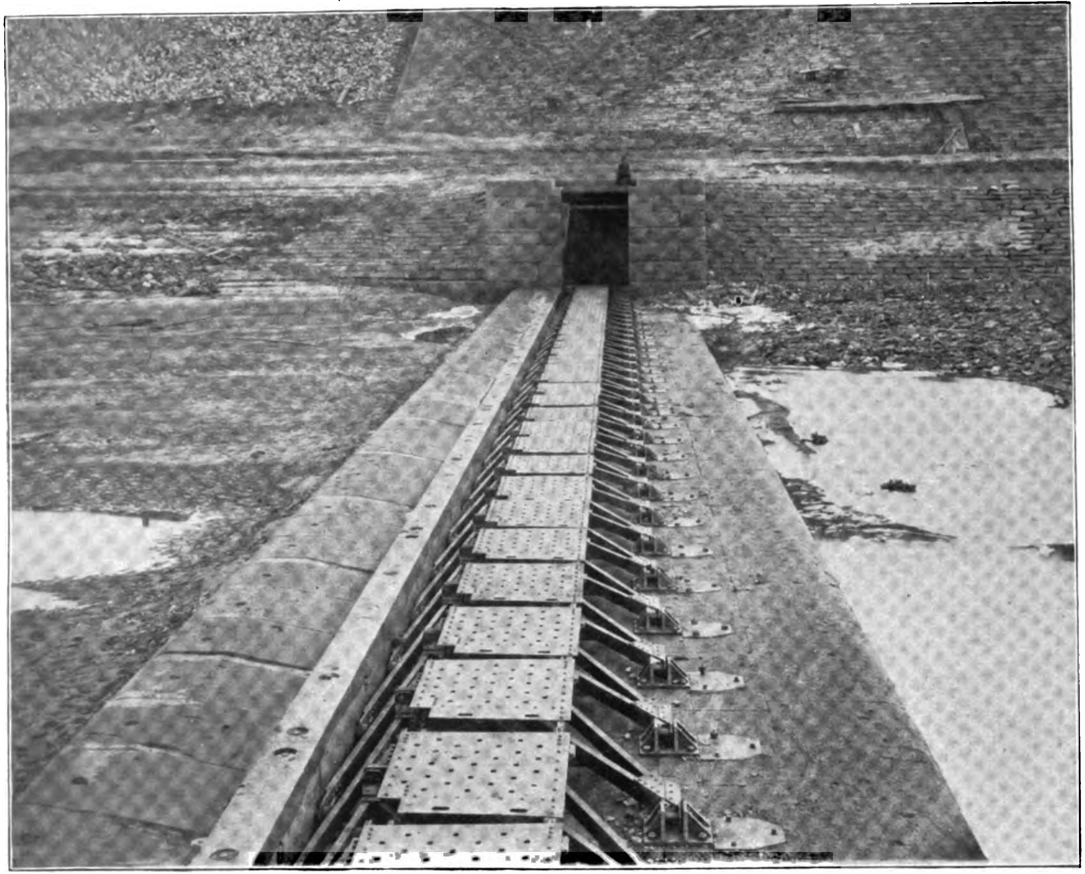
No. 2.—DOWNSTREAM VIEW OF PASS TRESTLES AND NEEDLES.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 2.—DOWNSTREAM VIEW OF PASS TRESTLES AND NEEDLES.

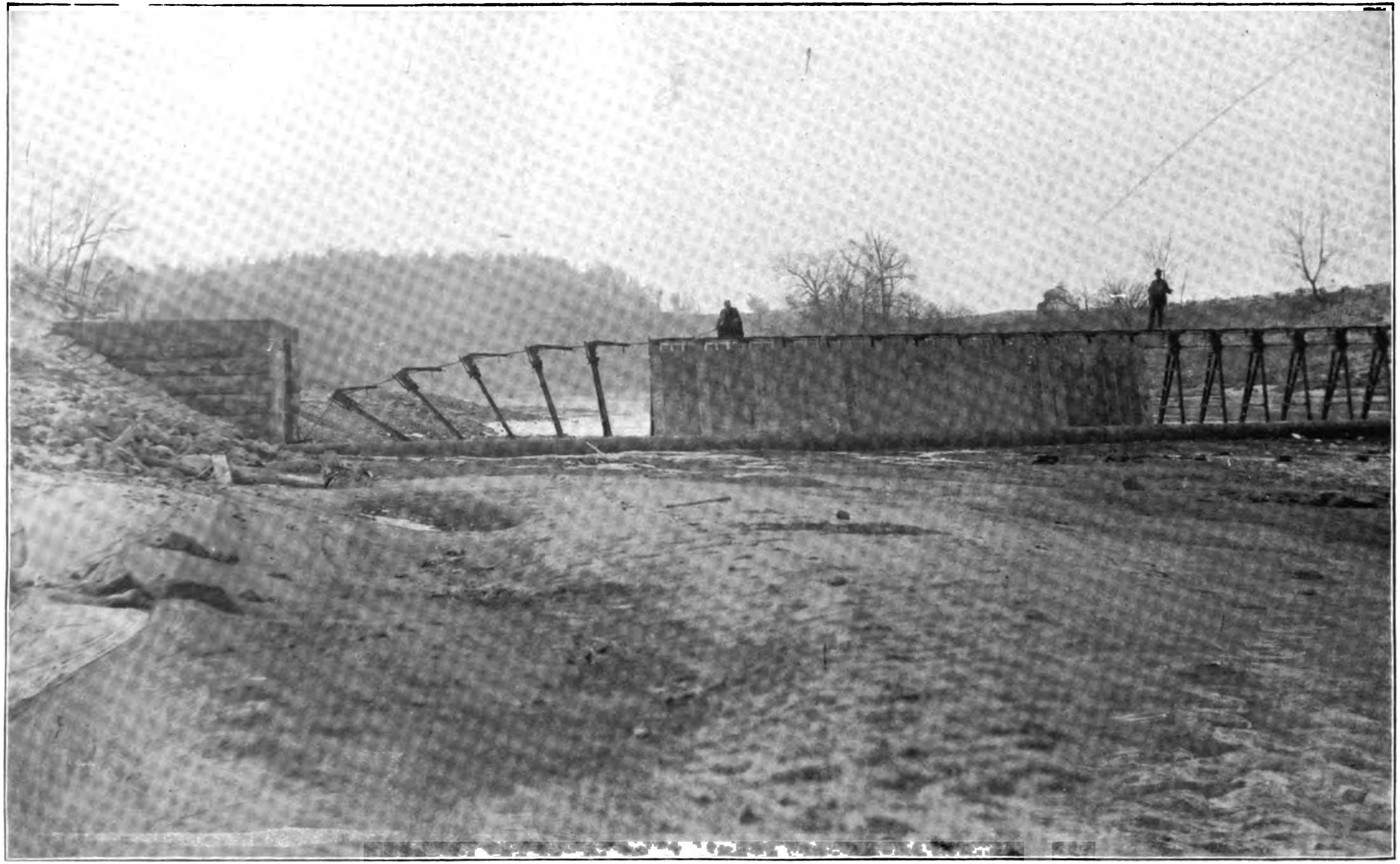
NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 3.—VIEW OF THE WEIR TRESTLES ALL FITTED AND IN PLACE.

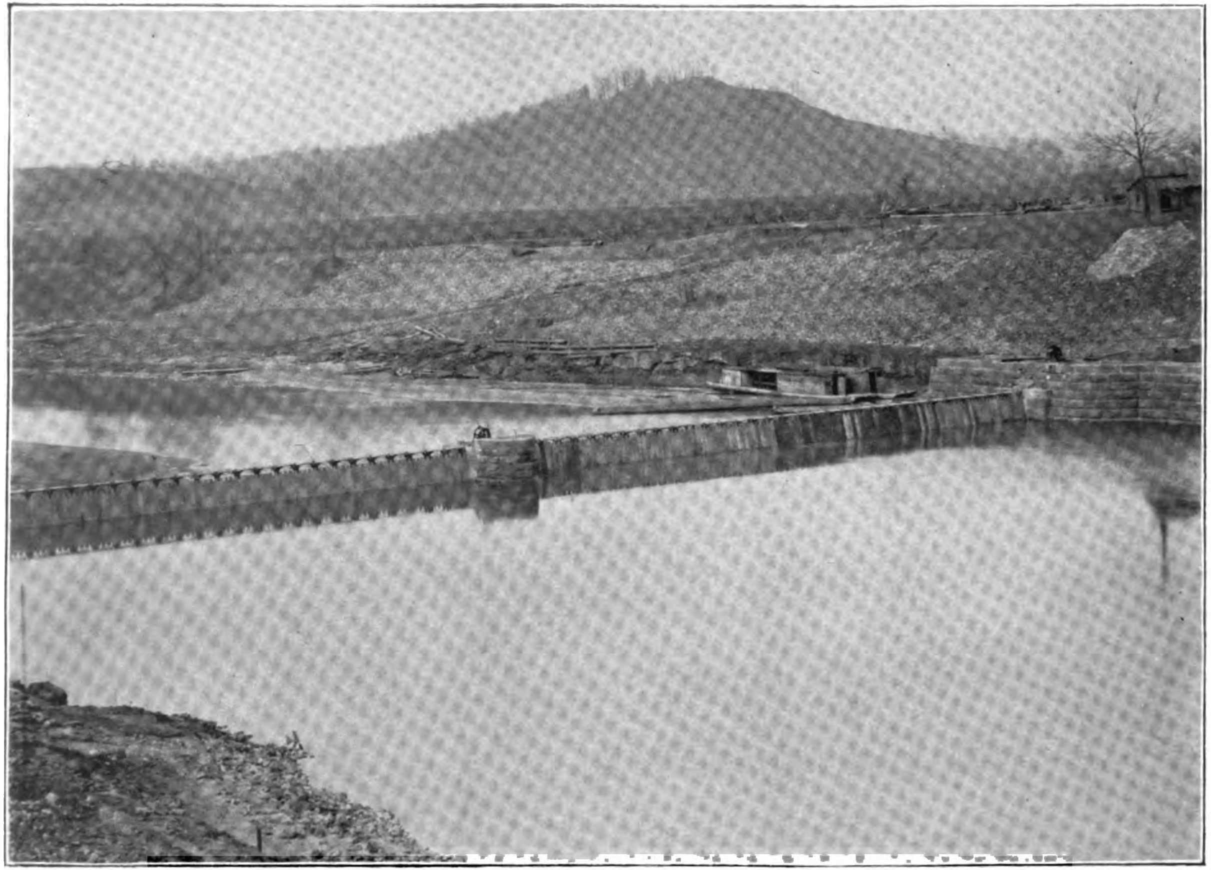
The ends of the escape bars are seen projecting on the left below the floors. The tops of the floors are about 2 inches below the top of the sill.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



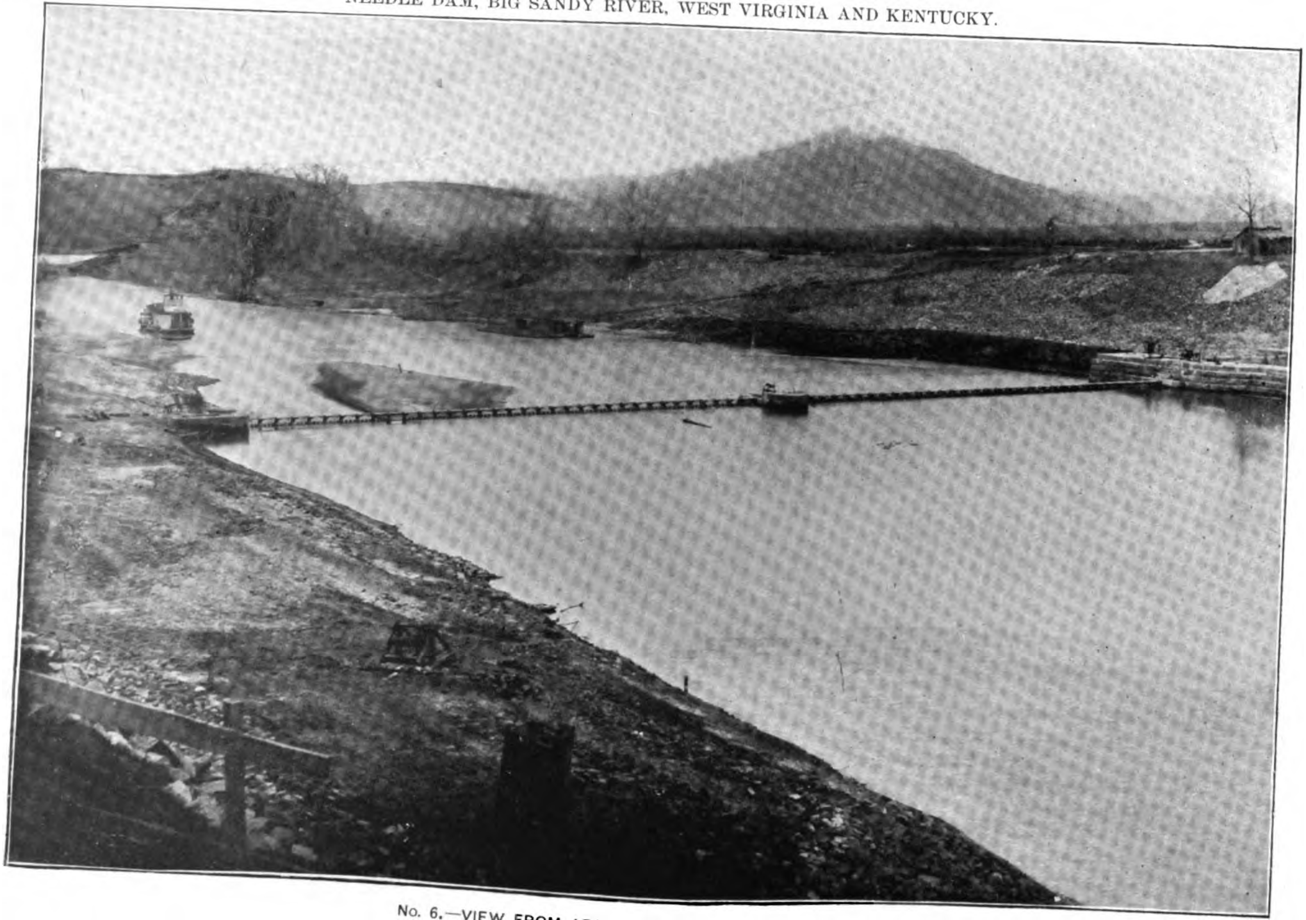
No. 4.—VIEW OF THE WEIR, SHOWING THE LAST TRESTLES BEING RAISED SIX AT A TIME.
The other trestles are all up and several bays of needles in place.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



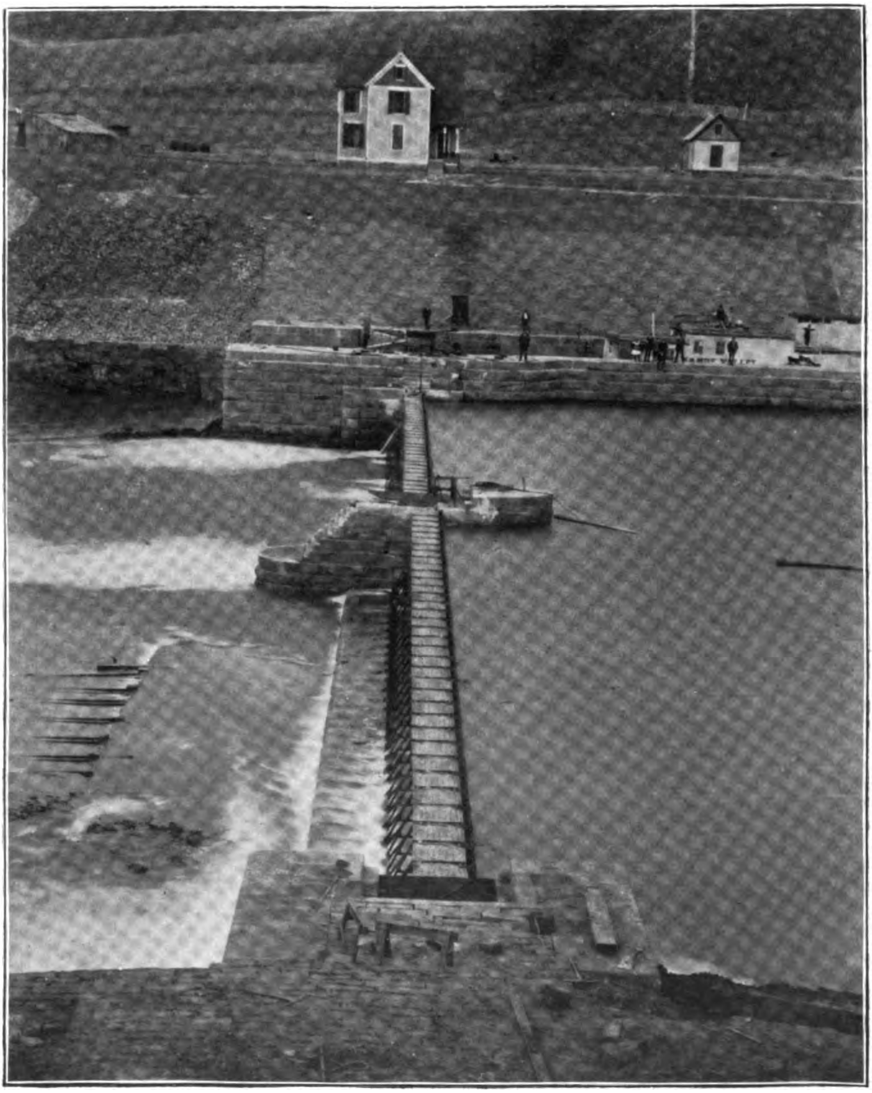
No. 5.—VIEW FROM ABOVE, SHOWING ALL TRESTLES AND NEEDLES IN POSITION AND THE POOL FILLING.
The pass is on the right, the weir on the left. The operating crabs are seen on the pier and on the lock wall.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 6.—VIEW FROM ABOVE, SHOWING THE POOL FULL.

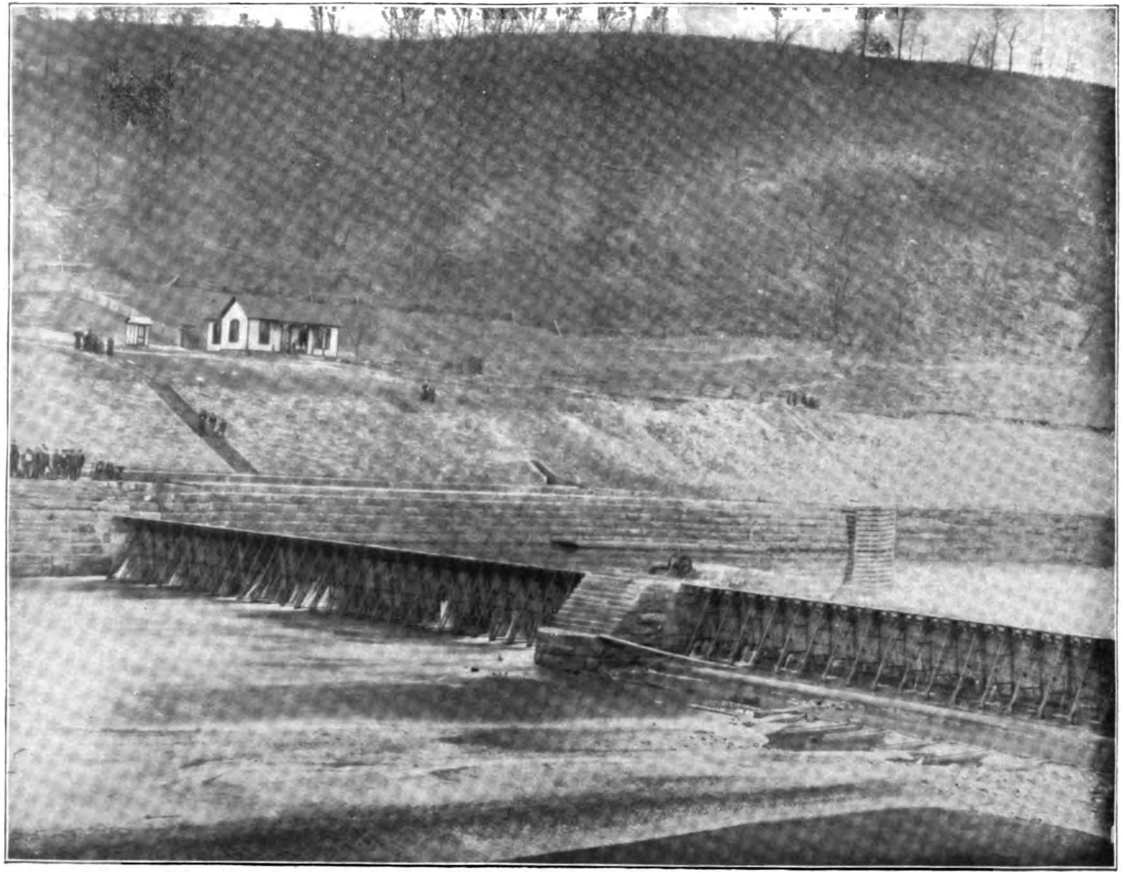
NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 7.—VIEW LOOKING TOWARD THE LOCK; POOL FULL.

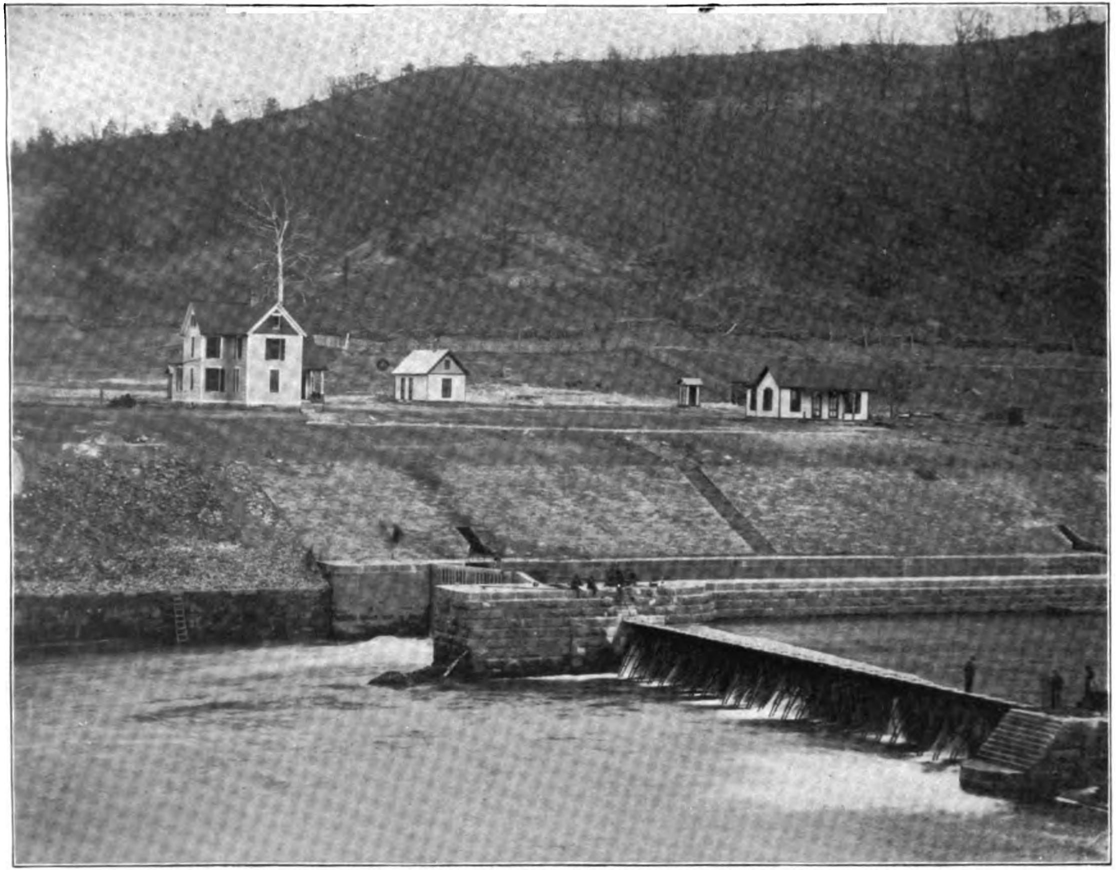
A few needles (two of which are seen floating on the pool) are removed to prevent overflow. The head of water on the pass is a little over 11 feet.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 8.—VIEW OF THE LOCK, THE PASS, AND THE WEIR FROM BELOW; THE DAM IS ALL IN PLACE.

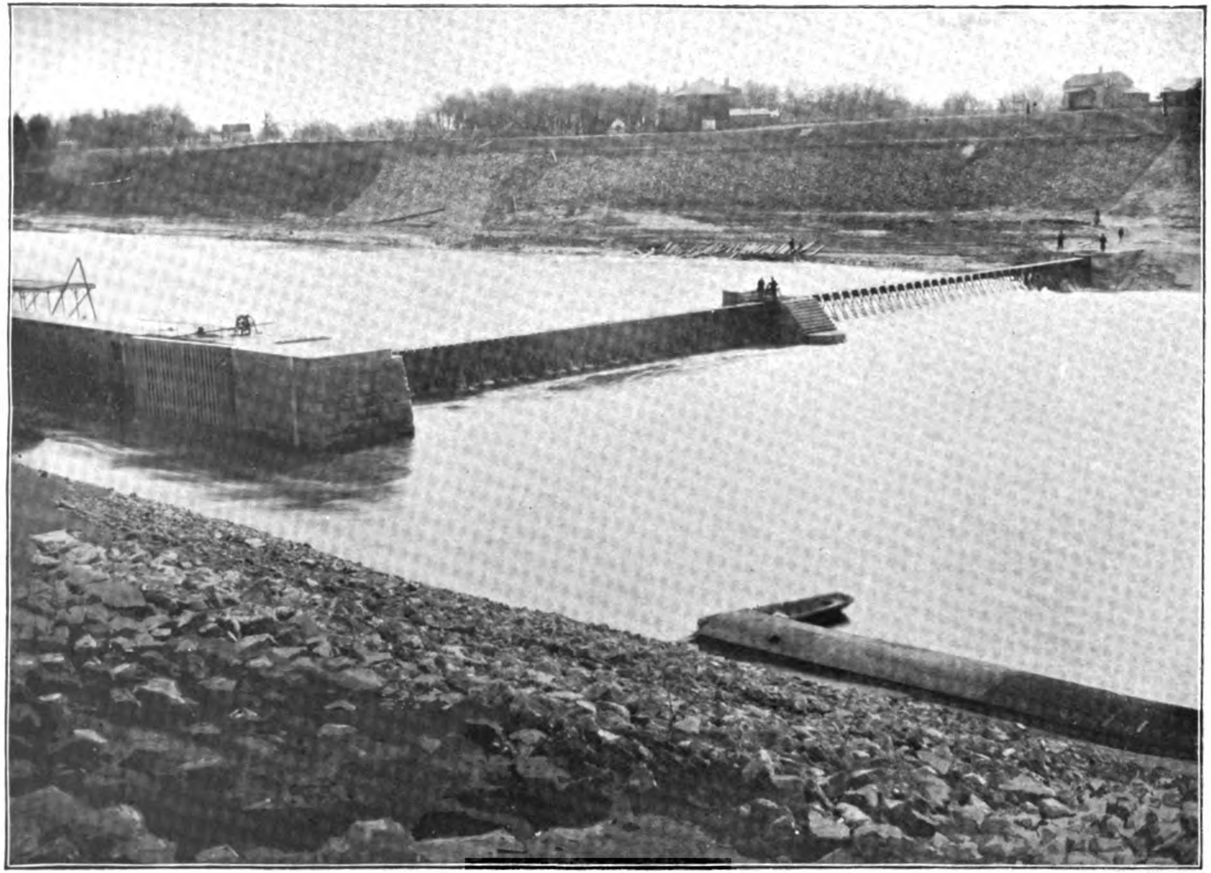
NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 9.—VIEW SHOWING THE GROUNDS, THE LOCK KEEPERS' DWELLINGS, ETC.

A few needles are removed, and the culvert wickets open.

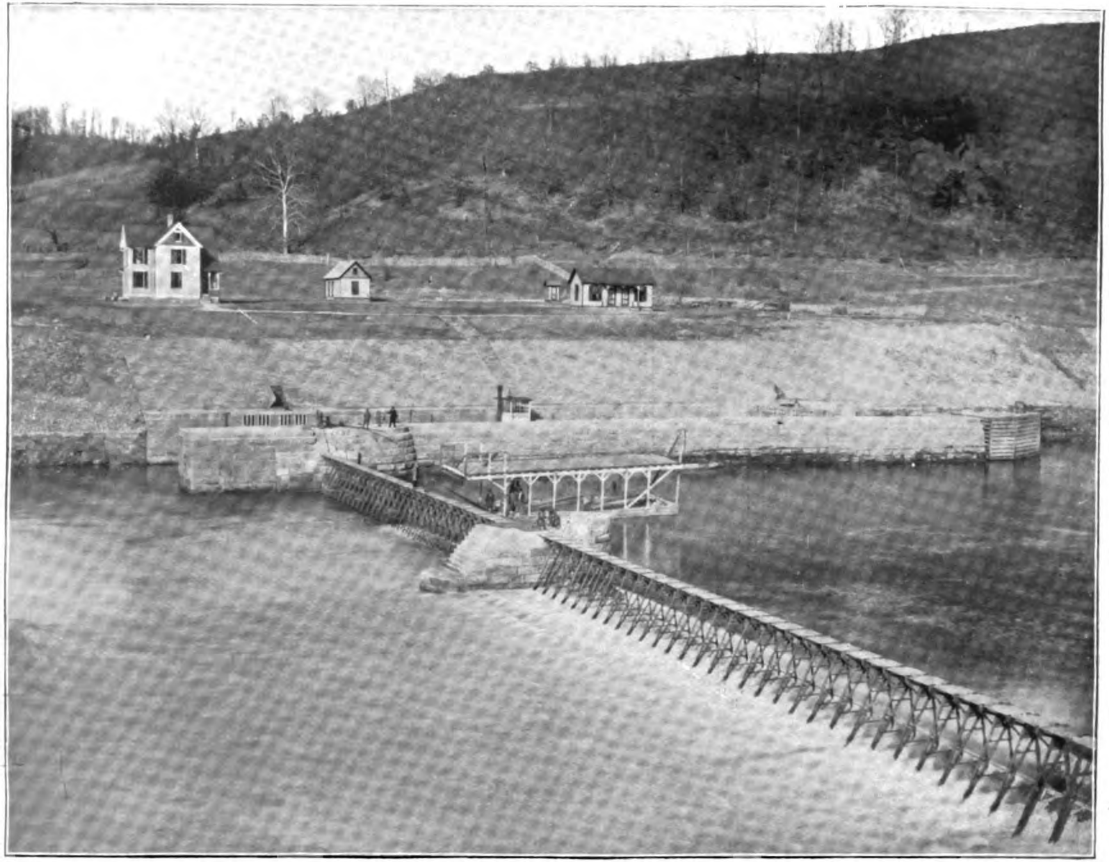
NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 10.—LOWERING THE DAM.

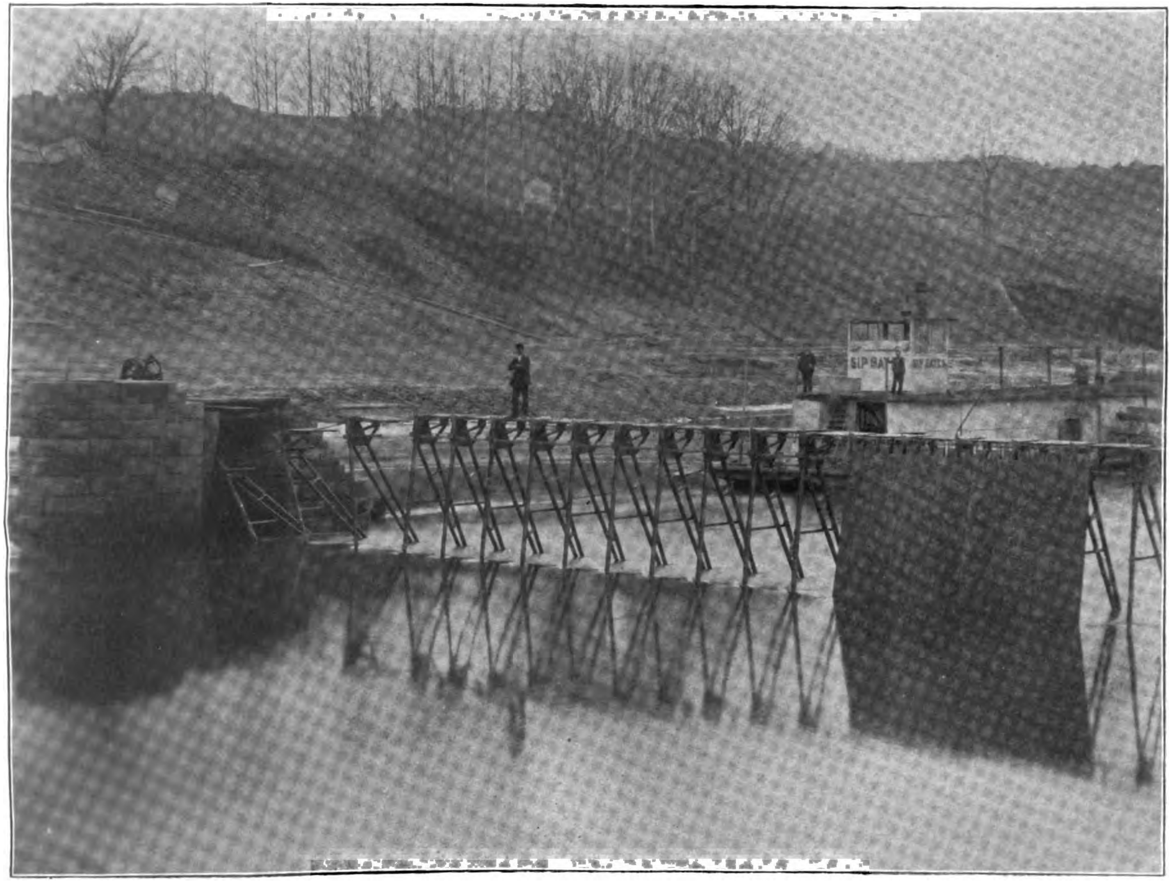
The weir needles have been pulled upstream and are seen lying along the bank. The pass needles are still in. The end of the needle boat is seen on the left.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 11.—THE PASS NEEDLES ARE BEING REMOVED BY THE NEEDLE BOAT. ONE NEEDLE IS BEING HOISTED IN, OTHERS ARE SEEN STORED ON THE DECK.

NEEDLE DAM, BIG SANDY RIVER, WEST VIRGINIA AND KENTUCKY.



No. 12.—VIEW SHOWING THE PASS TRESTLES BEING LOWERED.
The sliding floor is seen under the grating over the abutment recess. A few needles are on the right.

Commercial statistics for fiscal year ending June 30, 1897, Big Sandy River, West Virginia and Kentucky.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Timber	208, 491	225, 000	300, 050	331, 570	200, 000	425, 000	313, 332	255, 000
Hides	75	50	35	....	....	....	....	....
Leather	34	30	4	6	....	....	....	....
Lumber	3, 000	3, 000	60	650	400	500	370	300
Produce	2, 511	3, 000	250	1, 755	2, 000	3, 000	2, 360	5, 000
Live stock	495	500	150	1, 190	800	1, 360	1, 280	1, 400
Spokes	750	2, 200	4, 080	530	100	50	100	....
Staves	7, 000	1, 050	5, 260	1, 808	1, 500	1, 000	480	1, 000
Tan bark	9, 831	10, 000	28, 950	1, 950	1, 000	800	1, 000	800
Ties	15, 000	10, 000	99, 625	68, 750	40, 000	32, 100	51, 100	48, 000
Grain	510	489	....	....	....	....	....	500
Wool	11	15	7	7	....	....	....	....
Miscellaneous	19, 000	21, 069	16, 050	55, 914	50, 500	80, 000	100, 000	100, 000
Passengers	1, 874	900	1, 400	2, 503	1, 500	2, 100	1, 360	2, 500
Total	268, 582	277, 303	455, 926	466, 728	297, 800	545, 910	471, 382	414, 500

List of boats plying Big Sandy River, West Virginia and Kentucky.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Beulah Brown	Side-wheel	118	15	2.5	37.41
Sip Bayes	do	100	14	1.8	24.12
Andy Hatcher	Stern-wheel	117	18	3	65
J. C. Hopkins, No. 2	Side-wheel	120	18.4	4	56.28
Jennie George	do	93	14	2.5	19.05
Fairplay	do	125	19	3	49
Sandy Valley	do	105	14	2.8	40
Virgie Ratcliff	do	110	15	2.6	48
Stella (tow)	Stern-wheel	90	16	2	25
Buckeye Boy (tow)	do	137	20	3.5	....
Gate City (tow)	do	....	....	....	....
Sea Lion (tow)	do	123	22	3.5	127
J. H. McConnell (tow)	do	120	22	4	137
Lee H. Brooks (tow)	do	....	....	....	....
Champion (tow)	do	118	21	3.2	60.15
J. C. Hopkins (saw boat)	Side-wheel	102.5	16.4	2.4	67
B. A. Johnson	do	102.5	16.4	2.4	67
Estelle	do	103	10	2.5	18.35
Ometa	do	45.7	15.5	2.3	3.96
Nancy	Stern-wheel	83	6.5	2.2	....

Report of craft, rafts, etc., passing lock and dam on Big Sandy River near Louisa, Ky., during fiscal year ending June 30, 1897.

[No account was kept previous to January 1, 1897, the lock and dam not being completed.]

Craft, etc., passing.	Lock.		Pass.		Total.
	Up.	Down.	Up.	Down.	
Steamboats	20	25	296	278	619
Barges and flats	2	3	....	2	7
Log rafts	....	2	....	1, 390	1, 392
Loose logs	....	100	....	40, 000	40, 100
Tie rafts	....	6	....	23	29
Miscellaneous	3	2	....	8	13

Lock operated, 39 days; pass open, 142 days.

F F 6.

IMPROVEMENT OF GUYANDOTTE RIVER, WEST VIRGINIA.

The project for the improvement of this stream, adopted in 1878, provides for removing snags, rocks, and overhanging trees and forming low wing dams of loose stones at shoal places to concentrate and deepen the water at those points, so as to aid light-draft steamboat and raft navigation. The characteristics of the stream are described in the Annual Reports of the Chief of Engineers for 1875 (pp. 747–755), and 1895 (pp. 2517–2520), and 1896 (pp. 2324–2325).

For details of the work done during the past fiscal year attention is invited to the report of Mr. B. F. Thomas, assistant engineer, herewith.

The two milldams—Pecks, 7 miles below Logan, and Lamberts, 19 miles below Pecks—still constitute serious obstructions to navigation, and have been reported to the Department as such.

Considerable difficulty has been experienced during the past year in keeping the lower 4 or 5 miles of the stream free of timber so that small steamers could use that portion of the stream. This timber is floated down to the mouth of the river, caught in booms, rafted, and then held for a rise in the Ohio, on which it is floated down to market. A report on this subject was made under date of January 12, 1897. Further report will be made as soon as it is possible to obtain more definite information.

Money statement.

July 1, 1896, balance unexpended	$1,233.80
June 30, 1897, amount expended during fiscal year	1,152.59
July 1, 1897, balance unexpended	81.21
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	1,000.00

Appropriations.

June 18, 1878	$2,000	September 19, 1890	$2,000
March 3, 1879	1,000	July 13, 1892	2,000
June 14, 1880	2,000	August 18, 1894	2,000
March 3, 1881	3,500	June 3, 1896	1,000
August 2, 1882	2,000		
July 5, 1884*	2,000	Total	21,500
August 11, 1888	2,000		

*Made available by act of August 5, 1886.

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to report upon the improvement of the Guyandotte River, West Virginia, for the fiscal year ending June 30, 1897.

The work was in local charge of Mr. Lafayette Ward, sr., who started out with a crew about the 1st of August and returned the last of September, having cleaned the river for a distance of 51 miles to Hamilton Shoal. The principal work done was at Hamilton Shoal, Aaron Shoal, Hatfield Ford, Hatfield Shoal, McCoy Ripple, Laurel Hill Shoal, Four Mile Shoal, Letart Shoal, Stone Coal Shoal, Head of Falls, Falls of Guyandotte, Falls Bar, Johnsons Store, Salt Rock, Head of Hichman Bend, Smith Creek Bend, Bradys Landing, Dusenbergs Dam, Mouth of Bootens Creek, Dark Hollow, McCommas Bend, and lower end of Vinson farm.

A summary of work shows 116 snags, 17 trees, and 3 stumps removed, 30 trees topped, 871 cubic yards solid rock and 3,832 cubic yards loose rock taken out.

The drifting of loose logs in the river is very injurious to the walls of the shoals, as when the logs catch out the drifters tear down the walls in getting them back into the channel. In this way much work is required in the way of repairs.

The greatest difficulty in the navigation of this river is the milldams, two of which have been obstructions for years. Unless they are removed it is not advisable to expend very much money in improving navigation, as, no matter how well the balance of the river may be maintained, the milldams prevent the passage of steamboats, except at high stages of water. Some means of getting rid of them should be found before anything further is done toward the improvement, except to maintain the works already built.

The timber interest is the chief one of this river, but it is a constant menace to steamboat navigation. The running of loose logs is quite dangerous to boats, and when the logs arrive at the mouth of the river they are held in booms and rafted at leisure, thus closing the river frequently to steamboats. In order to prevent the obstruction of steamboats at the mouth a watchman was employed during the timber season, and this has resulted in somewhat improving matters, although there is still a disposition upon the part of the timber interests to monopolize the lower part of the river to the detriment of other navigation.

Respectfully submitted.

B. F. Thomas, *Assistant Engineer.*

Maj. James F. Gregory,
Corps of Engineers, U. S. A.

Commercial statistics for fiscal years ending June 30, 1891–1897, Guyandotte River, West Virginia.

Articles.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Cross-ties	....	12,500	60,000	40,000	35,000	40,000	50,000
Timber	60,000	90,000	120,940	100,000	210,000	160,000	90,000
Miscellaneous	1,128	1,300	1,310	1,221	2,400	2,000	3,300
Total	61,128	103,800	182,250	141,221	247,400	202,000	143,300

List of boats plying the Guyandotte River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Jennie George	Side-wheel	93	14	2.5	37.41
J. T. Hustler	do	75	16	2.2	16.68
Favorite	do	103	14.8	2.5	43.64
Guyandotte	do	104	16	2.8	43.83

F F 7.

IMPROVEMENT OF NEW RIVER, VIRGINIA AND WEST VIRGINIA.

[This work was in the charge of Col. Peter C. Hains, Corps of Engineers, until April 30, 1897.]

The charge of the improvement of New River was transferred to me on April 30, 1897, by Col. Peter C. Hains, Corps of Engineers, in accordance with instructions in letter of the Chief of Engineers to Colonel Hains, dated April 17, 1897.

The balance unexpended was furnished by the act of Congress of August 5, 1886, with the stipulation: "Continuing improvement between the lead mines, in Wythe County, and the mouth of Wilsons Creek, in Grayson County." By letter dated April 17, 1891, it was reported to the Chief of Engineers that any further improvement of that portion of the stream was wholly unnecessary, on account of changed conditions in late years. The Chief of Engineers, under date of April 23, 1891, stated that the Secretary of War had decided that the unexpended balance should be withheld from expenditure until further action is taken by Congress. Nothing has, therefore, been done toward improving the stream since that time.

Money statement.

July 1, 1896, balance unexpended	$2,308.94
July 1, 1897, balance unexpended	2,308.94

Appropriations.

August 14, 1876	$15,000	June 14, 1880	$24,000
March 3, 1879	12,000	August 2, 1882	12,000
March 3, 1881	24,000		
August 5, 1886	10,000	Total	112,000
June 18, 1878	15,000		

F F 8.

IMPROVEMENT OF GAULEY RIVER, WEST VIRGINIA.

[This work was in the charge of Col. Peter C. Hains, Corps of Engineers, until April 30, 1897.]

The charge of the improvement of Gauley River was transferred to me on April 30, 1897, by Col. Peter C. Hains, Corps of Engineers, in accordance with instructions in letter of the Chief of Engineers to Colonel Hains, dated April 17, 1897.

The project for open navigation was adopted in 1888, consequent to the report of examination dated December 26, 1887.

The season for economical operations in this stream is limited to a short period each year, when the stage of water is low and the temperature of it is warm. As these conditions did not at any time during the past season exist for a sufficient length of time to permit the resumption of operations nothing was done, the amount expended during the year being on account of liabilities contracted during the previous year.

Money statement.

July 1, 1896, balance unexpended	$4,030.72
June 30, 1897, amount expended during fiscal year	333.69
July 1, 1897, balance unexpended	3,697.03
Amount (estimated) required for completion of existing project	60,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.

Appropriations.

August 11, 1888	$3,000
September 19, 1890	3,000
July 13, 1892	3,000
August 18, 1894	3,000
June 3, 1896	3,000
Total	15,000

Commercial statistics for Gauley River, West Virginia.

Year.	Saw logs.	Lumber.	Staves.	Coal.	Shingles.	Railroad ties.	Timber tonnage.	Produce.	Total from Gauley.	Merchandise to Gauley.
	Feet.	*Feet.*		*Tons.*				*Tons.*	*Tons.*	*Tons.*
1888	691,800	2,585,300	177,400	......	....	....	7,121	26	7,151	750
1889	890,400	3,615,000	274,200	......	....	....	9,491	78	9,569	1,822
1890	384,800	4,452,500	....	......	....	....	9,676	90	9,766	1,985
1891	384,700	4,701,300	100,000	......	....	....	10,347	89	10,436	1,964
1892	261,170	5,249,200	1,200,000	......	111,000	....	9,527	103	9,630	3,083
1893	302,000	5,470,000	118,700	......	75,000	....	9,457	114	9,571	2,405
1894	523,000	4,765,000	483,000	525	....	....	8,506	218	9,244	2,398
1895	2,000,000	5,000,000	1,000,000	2,000	50,000	....	....	......	19,060	4,500
1896	500,000	7,000,000	1,585,400	......	....	15,000	....	......	19,110	1,500
1897	500,000	....	....	......	....	....	830	......	....	....

F F 9.

IMPROVEMENT OF ELK RIVER, WEST VIRGINIA.

[This work was in the charge of Col. Peter C. Hains, Corps of Engineers, until April 30, 1897.]

The charge of the improvement of Elk River was transferred to me on April 30, 1897, by Col. Peter C. Hains, Corps of Engineers, in accordance with instructions in letter of the Chief of Engineers to Colonel Hains dated April 17, 1897.

The project for "open navigation" was adopted in 1878; the estimated cost was placed at $100,000.

But little work was done during the past year, further operations being delayed, under authority of the Chief of Engineers dated July 6, 1896, pending the outcome of proceedings instituted by the United States attorney for the district of West Virginia for the purpose of securing the removal of the Frametown and Ashley dams, the principal obstructions now in the stream.

The report of Mr. Addison M. Scott, assistant engineer, in local charge of improvement of the stream, is herewith.

Money statement.

July 1, 1896, balance unexpended	$3,877.95
June 30, 1897, amount expended during fiscal year	381.65
July 1, 1897, balance unexpended	3,496.30
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	69,000.00

Appropriations.

June 18, 1878	$5,000	September 19, 1890	$2,500
June 14, 1880	5,000	July 13, 1892	2,500
March 3, 1881	5,000	August 18, 1894	2,000
August 2, 1882	2,000	June 3, 1896	2,000
August 5, 1886	1,500		
August 11, 1888	3,000	Total	30,500

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1897.

MAJOR: I have the honor to submit the following report on the improvement of Elk River, West Virginia, for the year ending June 30, 1897:

The only work done during the year consisted in cutting up and removing five large trees and several smaller ones that had lodged in the channel at Blue Creek

Shoal, 14 miles above Charleston. These obstructions, left in by high water in February, made the passage of the chute through the shoal dangerous to rafts and push boats.

Operations have been practically suspended on this improvement since 1894 (reports of Chief of Engineers for 1895 and 1896), awaiting decision of the Department of Justice regarding the removal of the several old milldams on the river. As shown in the report of the Chief of Engineers for 1896, part 6, page 3876. proceedings were instituted against the owners of the Frametown Dam, "making of this a test case," in May, 1896. Though action has been repeatedly urged by this office during the year, I am obliged to report continued slow progress by the Department of Justice in the matter. The present legal status of the case was reported to you in a communication from this office dated June 25, 1897.

With the exception of these old dams the river is now in a fairly good and a pretty uniform condition for the lumbering business—mainly rafting and driving saw logs and ties in flush stages of the river. This now constitutes nearly all of the traffic. These old dams are real hindrances to navigation, much more so than any natural obstructions left in the river. (See also report of Chief of Engineers for 1893, pp. 2595 and 2597). All considered, it would seem advisable to hold the money now available, or the principal part of it at least, until the legal questions connected with these old milldams are settled.

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

Commercial statistics for Elk River, West Virginia.

Year.	Saw logs and lumber.	Railroad ties, oak.	Staves, oak.	Hoop poles.	Hickory spokes.	Tan bark and wood.	Tonnage of timber products.
	Feet.					*Cords.*	
1883	5,200,000	100,000	898,834	....	....	....	24,790
1884	5,975,000	125,000	1,122,500	....	....	....	30,700
1885	5,100,000	250,000	1,433,750	....	....	....	33,500
1886	15,361,000	250,000	1,845,000	....	....	....	68,510
1888	15,900,000	330,000	1,210,000	....	....	....	71,150
1889	15,750,000	295,000	1,600,000	500,000	350,000	....	70,200
1890	26,650,000	330,000	1,380,000	150,000	568,000	300	89,890
1891	27,995,000	412,500	800,000	125,000	200,000	500	108,700
1892	44,400,000	380,000	1,405,000	....	....	240	139,800
1893	37,516,000	353,000	1,390,000	....	....	612	125,400
1894	21,844,000	302,000	900,000	....	....	800	92,630
1895	31,160,000	289,000	1,662,000	280,000	....	1,800	112,100
1896	29,321,000	214,000	250,000	....	....	4,800	92,000
1897	23,945,000	287,000	....	....	....	4,800	92,100

F F 10.

IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

[This work was in the charge of Col. Peter C. Hains, Corps of Engineers, until April 30, 1897.]

The charge of the improvement of this stream was transferred to me on April 30, 1897, by Col. Peter C. Hains, Corps of Engineers, in accordance with instructions in letter of the Chief of Engineers to Colonel Hains dated April 17, 1897.

The present project for the improvement of this stream, that is, the modified project of 1875, provides for dredging channels where needed and the extension of 6 feet of slack-water navigation for a distance of about 96 miles upstream from the mouth of the river in the Ohio, at Point Pleasant, W. Va., by the construction of locks and dams (Annual Report, Chief of Engineers, 1875, part 2, pp. 90–98). This project provided for twelve locks and dams, three locks with fixed dams in the upper portion of the river, and nine locks with movable dams in the remainder of the river. This was later on changed so that there should be but two locks with fixed dams in the upper river and eight locks with movable dams in the remainder of the river. The two locks with fixed dams in the upper part of the river and five of the locks with movable dams in the remainder of the stream are completed and in operation, as shown in the table printed on page 2247 of the Annual Report of the Chief of Engineers for 1896, part 4.

The work done during the past year has been on Locks and Dams 9, 10, and 11, the lower three works in the stream, the completion of which will practically complete the present project.

Mr. Addison M. Scott, assistant engineer, in direct local charge of the improvements being conducted in the stream, so well describes in his report herewith the progress made during the past year that nothing remains to be added, excepting the following outline of the manner in which the work has been carried on.

LOCKS AND DAMS NOS. 9, 10, AND 11.

The masonry work of Lock No. 9, and that of the abutment, center pier, foundations of navigation pass, and weir of Dam No. 9 are being constructed under a continuing contract with Zimmerman, Truax & Sheridan dated May 23, 1893. Work was begun by the contractors in June, 1893, and the contract expires December 31, 1897, having been extended to that date by authority of the Chief of Engineers dated November 21, 1896.

The masonry work of Lock No. 10, and that of the abutment, center pier, foundations of navigation pass, and weir of Dam No. 10 are being constructed under a continuing contract with Zimmerman, Truax & Sheridan dated June 5, 1893. Work was begun by the contractors in June, 1893, and the contract expires December 31, 1897, having been extended to that date by authority of the Chief of Engineers dated November 21, 1896.

The masonry work of Lock No. 11, and that of the abutment, center pier, foundations of navigation pass, and weir of Dam No. 11 are being constructed under a continuing contract with Thomas Munford dated June 1, 1893. Work was begun by the contractor in June, 1893, and the contract expires December 31, 1897, having been extended to that date by authority of the Chief of Engineers dated November 13, 1896.

The iron work for Dams 9, 10, and 11 was purchased of the Youngstown Bridge Company under contract dated October 5, 1894. Work was begun by the contractor in October, 1894, and was completed May 15, 1896.

The ironwork for the weirs of Dams 9, 10, and 11, i. e., the fixed and movable irons, was purchased of the Youngstown Bridge Company under contract dated December 18, 1895. Work was begun by the contractor in February, 1896, and was completed in April, 1897, the contract having been extended to April 1, 1897, by authority of the Chief of Engineers.

The white-oak timber for gates of Locks 9, 10, and 11 and for wickets of Dams Nos. 9, 10, and 11 was purchased of George Miller Donaldson, under contract dated January 7, 1896. Work was begun in January, 1896, and was completed in December, 1896, the contract having been extended to December 15, 1896, by authority of the Chief of Engineers.

The ironwork for the gates for Locks 9, 10, and 11 was purchased of the Fort Pitt Bridge Works, of Pittsburg, Pa., under contract dated December 12, 1896. The work on this contract was pushed so that it was completed in May, 1897, although the contract was not to expire until August 15, 1897.

The construction of the lock gates for Locks 9, 10, and 11 and the construction of the wickets of their dams, including the placing of the ironwork, has been carried on by hired labor.

MISCELLANEOUS.

U. S. towboat *Bee* and the U. S. dredge dredged the stream at several points between locks where the channel required to be widened and deepened; the towboat underwent some repairs; the telephone line connecting the United States engineer office at Charleston with the different locks and dams was maintained, etc., all by hired labor.

Under date of December 14, 1896, Colonel Hains submitted a revised estimate of the cost of completing the present project for the improvement of this stream. A copy of this estimate is herewith; the amount of it, $273,000, was furnished by the sundry civil act approved June 4, 1897. This amount, together with the unexpended balance remaining from the appropriation of March 2, 1895, will, it is believed, be sufficient to complete the present project.

Six photographs—three of Lock and Dam No. 9, and three of Lock and Dam No. 11—taken in September and October, 1896, accompany this report. The three photographs of No. 11, together with those between pages 2260 and 2261 of part 4 of the Annual Report of the Chief of Engineers for 1896, illustrate the work at No. 11 quite fully.

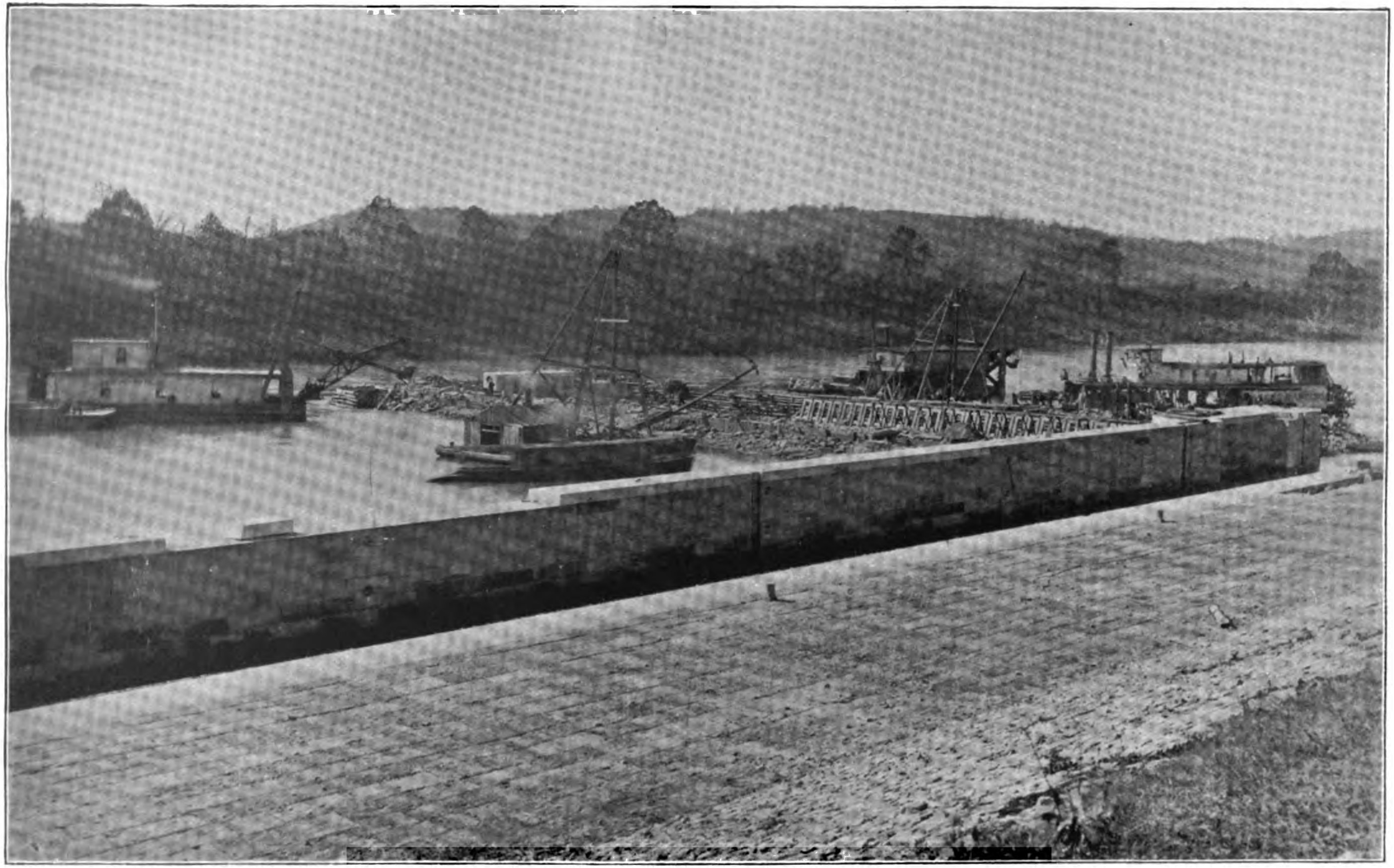
Money statement.

July 1, 1896, balance unexpended		$485,270.32
Amount appropriated by sundry civil act approved June 4, 1897		273,000.00
		758,270.32
June 30, 1897, amount expended during fiscal year		204,591.07
July 1, 1897, balance unexpended		553,679.25
July 1, 1897, outstanding liabilities	$19,195.91	
July 1, 1897, amount covered by uncompleted contracts	408,172.73	
		427,368.64
July 1, 1897, balance available		126,310.61

Appropriations.

March 3, 1873	$25,000	August 5, 1886	$187,500
June 23, 1874	25,000	August 11, 1888	350,000
March 3, 1875	300,000	September 19, 1890	300,000
August 14, 1876	270,000	July 13, 1892	225,000
June 18, 1878	222,000	March 3, 1893	500,000
March 3, 1879	150,000	March 2, 1895	580,700
June 14, 1880	200,000	June 4, 1897	273,000
March 3, 1881	200,000		
August 2, 1882	200,000	Total	4,208,200
July 5, 1884	200,000		

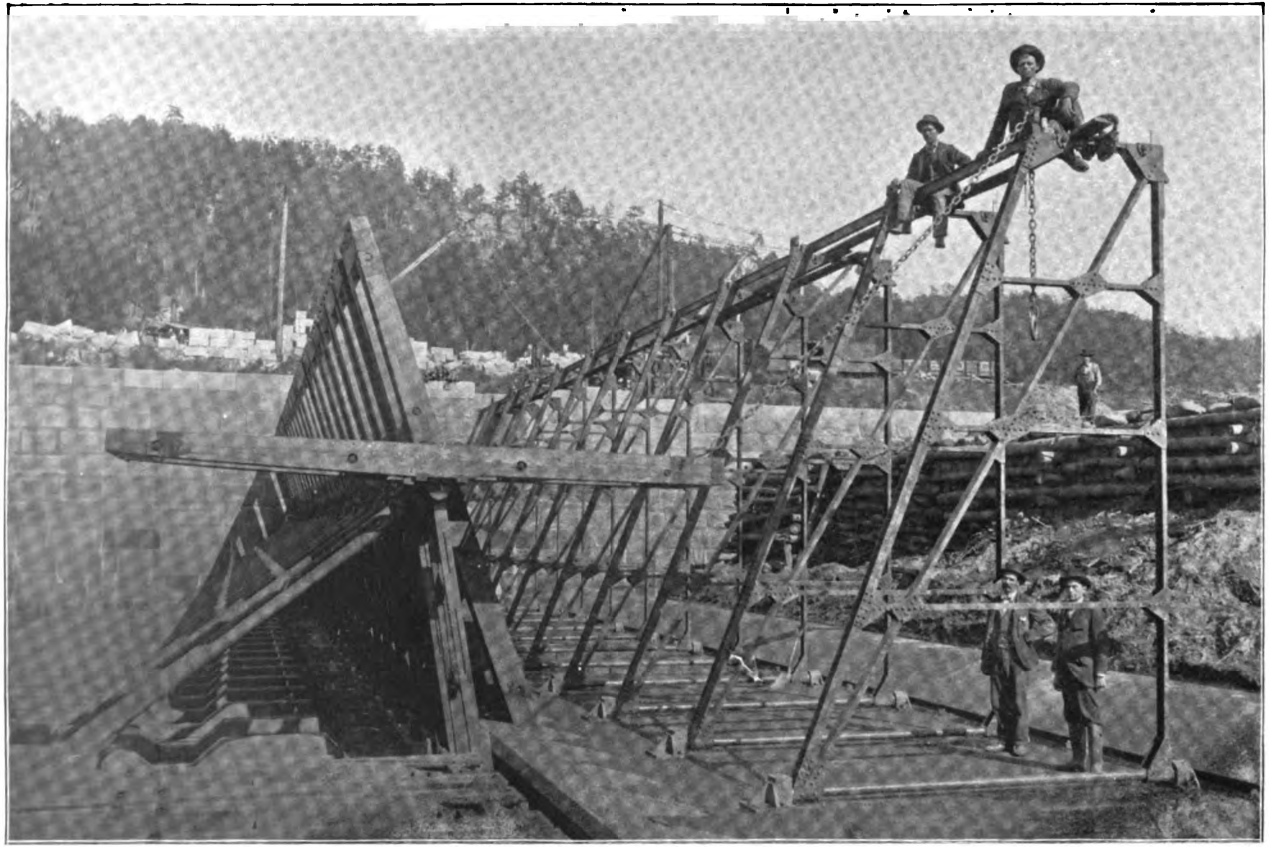
UNITED STATES IMPROVEMENT, GREAT KANAWHA RIVER, WEST VIRGINIA.



LOCK AND DAM No. 9 DURING CONSTRUCTION. VIEW TAKEN OCTOBER 21, 1896.

From the top of bank near head of lock. Work inside the cofferdam for the navigation pass and center pier nearly finished. See views taken the same day inside of this cofferdam. The masonry of the lock was completed, except a few pieces of coping still to set.

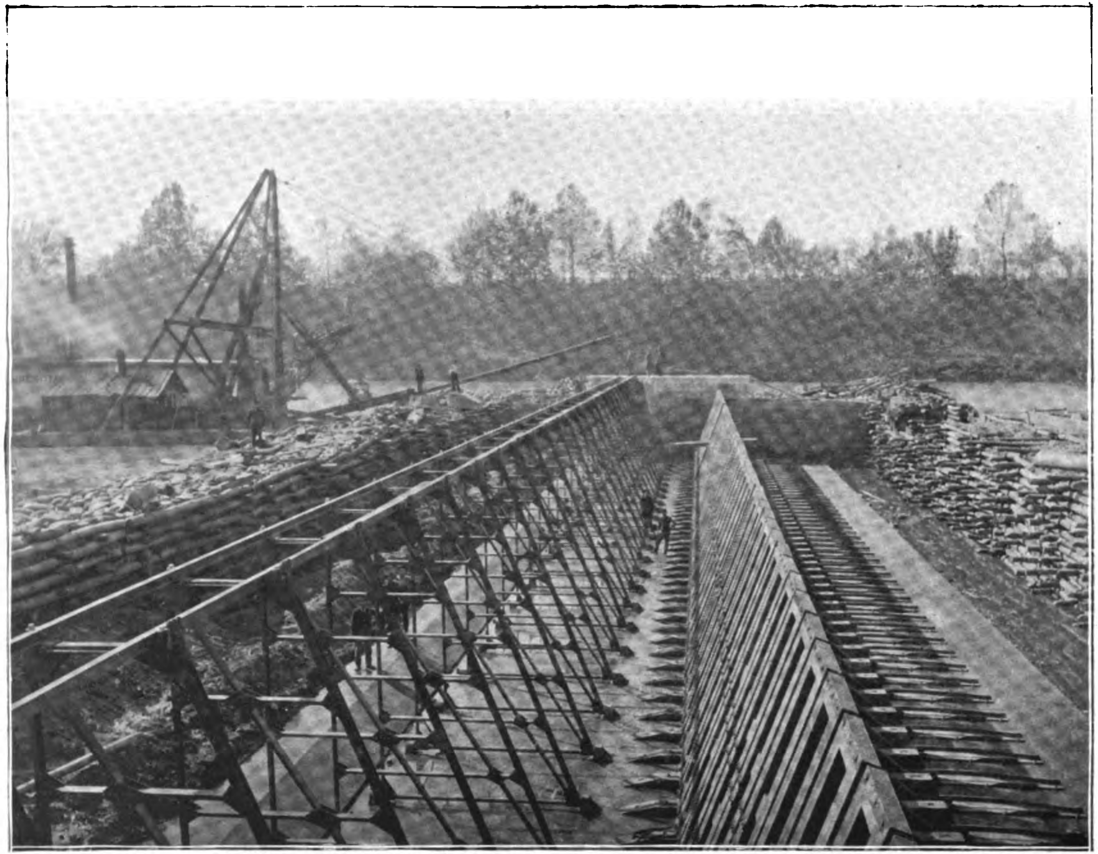
UNITED STATES IMPROVEMENT, GREAT KANAWHA RIVER, WEST VIRGINIA.



LOCK AND DAM No. 9 DURING CONSTRUCTION. VIEW TAKEN OCTOBER 21, 1896.

Inside the cofferdam for the navigation pass. Showing some of the wickets and part of the service bridge next to the lock wall standing. Wicket in foreground "on the swing" (*en bascule*). The aprons for the walk of the service bridge and the wicket and trestle chains had not been placed.

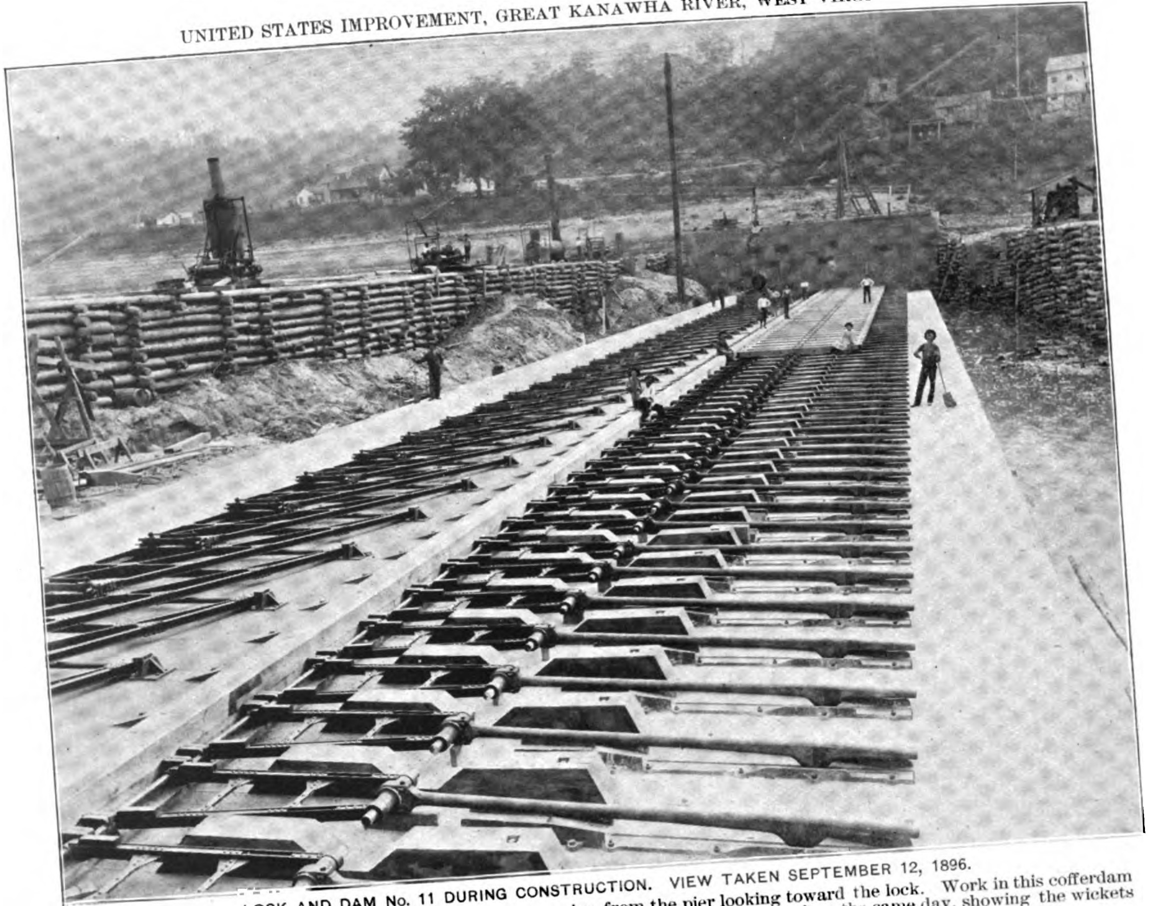
UNITED STATES IMPROVEMENT. GREAT KANAWHA RIVER. WEST VIRGINIA.



LOCK AND DAM No. 9 DURING CONSTRUCTION. VIEW TAKEN OCTOBER 21, 1896.

Inside the cofferdam for the navigation pass and center pier, from the lock looking toward the pier. Work inside this cofferdam nearly completed. The wickets lack the panel plank of being finished. The aprons for the walk of the service bridge and the chains for the trestles and wickets are yet to be placed. One of the wickets out near the pier is "on the swing."

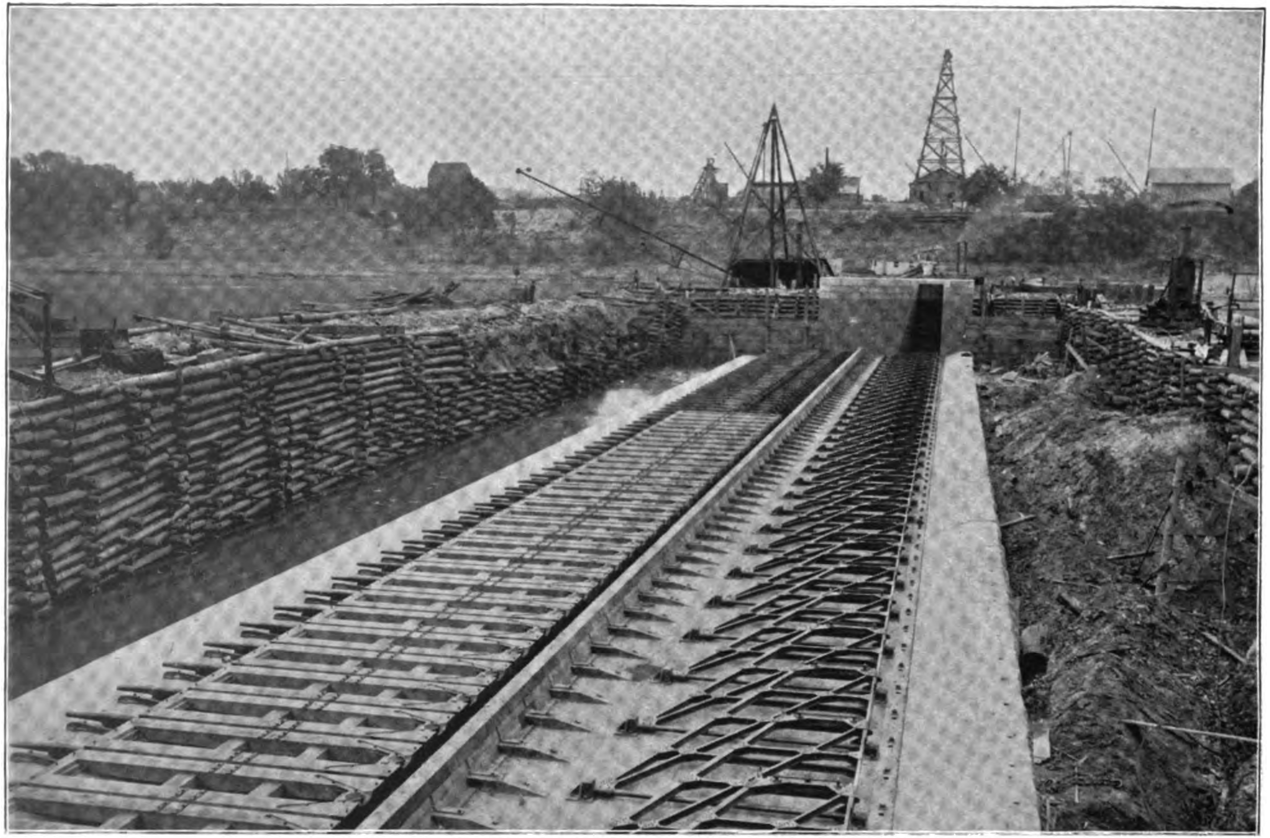
UNITED STATES IMPROVEMENT, GREAT KANAWHA RIVER, WEST VIRGINIA.



LOCK AND DAM No. 11 DURING CONSTRUCTION. VIEW TAKEN SEPTEMBER 12, 1896.

Inside the cofferdam for the navigation pass and center pier, from the pier looking toward the lock. Work in this cofferdam shown nearly completed, except the placing of part of the wickets. See view taken the same day, showing the wickets and service bridge standing.

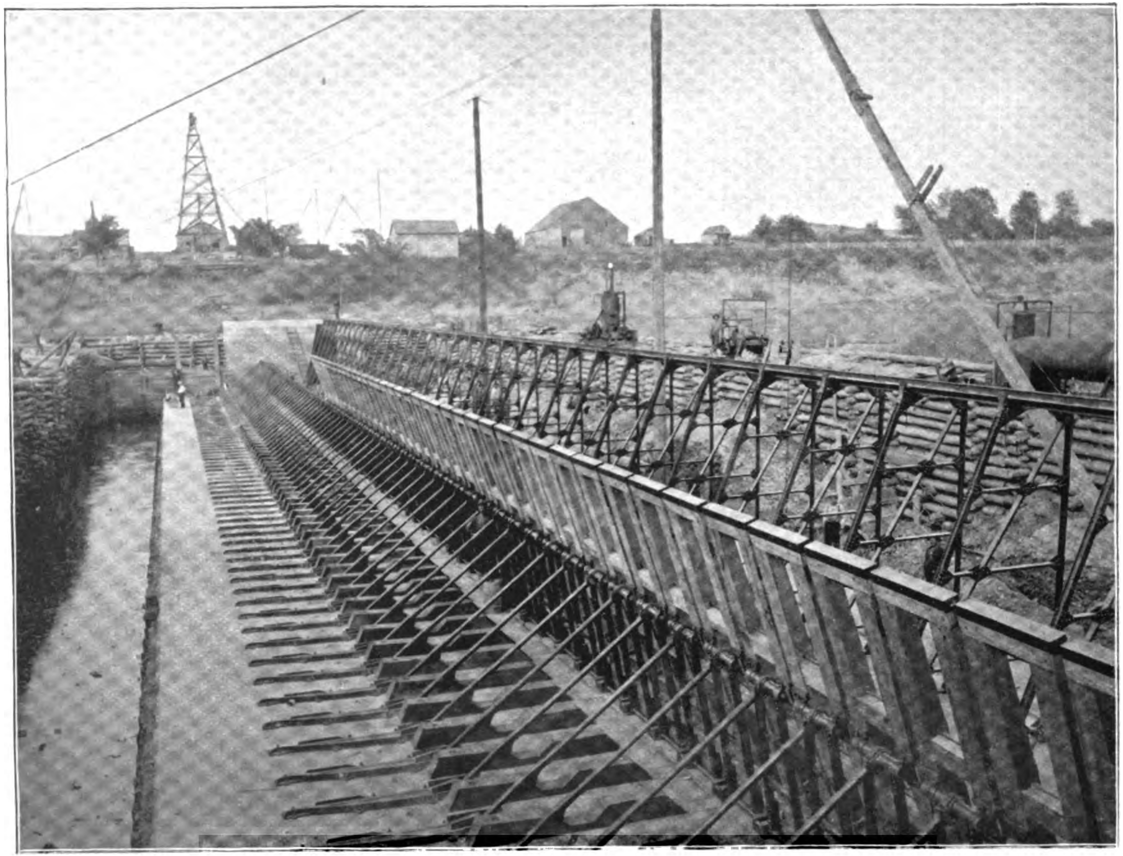
UNITED STATES IMPROVEMENT, GREAT KANAWHA RIVER, WEST VIRGINIA.



LOCK AND DAM No. 11 DURING CONSTRUCTION. VIEW TAKEN SEPTEMBER 12, 1896.

View inside the cofferdam for the navigation pass and center pier, from the lower end of the lock. Work inside this cofferdam nearly finished. Some of the wickets toward the pier end of the pass yet to be placed. The wickets placed lack the panel plank of being finished. The aprons forming the service bridge and the wicket and trestle chains had not been placed. See view taken the same day showing wickets and trestles standing.

UNITED STATES IMPROVEMENT. GREAT KANAWHA RIVER, WEST VIRGINIA.



LOCK AND DAM No. 11 DURING CONSTRUCTION. VIEW TAKEN SEPTEMBER 12, 1896.

View inside the cofferdam for the navigation pass and center pier, from the lower end of the lock. Work inside this cofferdam nearly completed. Part of the wickets toward the pier end to be placed. The wickets placed lack the panel plank of being finished. The wicket and trestle chains are also to be added.

REVISED ESTIMATE FOR COMPLETING THE IMPROVEMENT OF GREAT KANAWHA RIVER, WEST VIRGINIA.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., December 14, 1896.

GENERAL: In compliance with orders contained in your letter dated September 18, 1896, I have the honor to submit the following statement with reference to the necessity for an additional appropriation for the improvement of the Great Kanawha River, West Virginia:

The estimate for completing the improvement of the Great Kanawha River was made January 8, 1892, and is contained in your Annual Report for that year, pages 2042–2044. At the time that estimate was made the exact site for Lock and Dam No. 11 had not been determined, but the estimate was believed to be sufficient to cover all expenses, and was made from the best available data. Subsequently, when the exact site was fixed and work begun, it was found that, owing to the character of the substrata on which the lock and dam rests, it was necessary to carry the foundations down several feet (an average of 3) below what was anticipated, so that the quantities of those items that enter into the construction of the lower part of the work had to be largely increased. This has made the cost of Lock and Dam No. 11 run very considerably above the estimate.

Moreover, the estimate for dredging the pools was largely underestimated. This was not the fault of the engineer, but was due to a less thorough knowledge of the obstructions than now exists.

Another factor also was a most potent one in increasing the actual cost of all the contracts made in 1893 for labor and material in construction of Locks and Dams Nos. 9, 10, and 11. That was the eight-hour law, which was passed August 1, 1892. A careful examination of the cost of identical items in Locks and Dams Nos. 9, 10, and 11 shows that the prices were increased on an average about 12 per cent over what they had cost at Locks 7 and 8, previously constructed.

In the light of the most recent information, gained by long experience on the river, it is estimated that it will cost—

To complete the improvement		$516,088
There is in the subtreasury and the Treasury	$331,095	
But of that amount in the Treasury the contractors have earned and are to be paid (retained money)	88,007	
Leaving available for the work		243,088
And making necessary to be supplied by appropriation		273,000

As nearly as can now be estimated, this additional sum is made up as follows:

Extra cost of contracts, due to the eight-hour law 12 per cent increase	$126,000
Extra dredging needed	29,000
Extra depth of foundations at No. 11, and freshets which have necessitated the frequent removal of silt inside the dam	118,000
Total	273,000

It is important that the additional appropriation be made at this session of Congress, as otherwise the work will come to a stop in an unfinished condition. This would not only increase the cost still more, but would be scarcely less than a disaster to the improvement of the Great Kanawha River.

Very respectfully, your obedient servant,

PETER C. HAINS,
Colonel, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

Abstract of proposals for ironwork for gates of Locks Nos. 9, 10, and 11, Great Kanawha River improvement, opened at United States Engineer office, Charleston-Kanawha, W. Va., December 1, 1896.

[Materials and approximate quantities.]

No.	Name and address of bidder.	Wrought iron, 146,000 pounds.		Cast iron, 91,000 pounds.		High and cast steel, 3,860 pounds.		Bronze, 940 pounds.		Total.
		Bid.	Amount.	Bid.	Amount.	Bid.	Amount.	Bid.	Amount.	
		Cents.		*Cents.*		*Cents.*		*Cents.*		
1	Rogers, Haller & Farrell, Cincinnati, Ohio	$4\frac{78}{100}$	$6,978.80	$3\frac{2}{10}$	$2,912.00	$20\frac{1}{2}$	$791.80	$18\frac{3}{4}$	$176.25	$10,858.85
2	John P. McGuire, Cleveland, Ohio	$3\frac{3}{4}$	5,475.00	$3\frac{3}{10}$	3,003.00	18	694.80	24	225.60	9,398.40
3	Fort Pitt Bridge Works, Pittsburg, Pa	$4\frac{44}{100}$	6,482.40	$2\frac{44}{100}$	2,220.40	$9\frac{94}{100}$	383.68	$17\frac{44}{100}$	163.94	9,250.42
4	Smead & Co. Iron Works, Incp., Louisville, Ky	$8\frac{10}{100}$	11,826.00	$7\frac{59}{100}$	6,906.90	$16\frac{15}{100}$	623.39	$33\frac{75}{100}$	317.25	19,673.54
5	Hoefinghoff & Laue Foundry Co., Cincinnati, Ohio	$4\frac{52}{100}$	6,599.20	3	2,730.00	15	579.01	22	206.80	10,115.00
6	Weimer Machine Works Co., Lebanon, Pa	$4\frac{9}{10}$	7,154.00	3	2,730.00	$24\frac{1}{2}$	945.70	70	658.00	11,487.70
7	Wisconsin Bridge and Iron Co., Milwaukee, Wis	$4\frac{98}{100}$	7,270.80	$4\frac{78}{100}$	4,349.80	10	386.00	20	188.00	12,194.60

Contract awarded to Fort Pitt Bridge Works.

Abstract of contracts for improving Great Kanawha River, West Virginia, in force during the fiscal year ending June 30, 1897.

Contractor.	Nature of contract.	Date.	To expire.
Jacob Zimmerman, Albert H. Truax, Thos. A. Sheridan.	Building Lock and Dam No. 9	May 23, 1893	*a* Dec. 31, 1896
Do	Building Lock and Dam No. 10	June 5, 1893	*a* Do.
Thos. Munford	Building Lock and Dam No. 11	June 1, 1893	*a* Do.
Fort Pitt Bridge Works	Ironwork for lock gates for Locks 9, 10 and 11.	Dec. 12, 1896	*b* Aug. 15, 1897
Youngstown Bridge Co	Ironwork for weirs Dams 9, 10 and 11	Dec. 18, 1895	*c* Apr. 1, 1897
George Miller Donaldson	White-oak timber for gates and wickets of Locks and Dams Nos. 9, 10 and 11.	Jan. 7, 1896	*d* Dec. 15, 1896

a Extended to December 31, 1897.
b Completed in May, 1897.
c Completed in April, 1897.
d Completed in December, 1896.

NOTE.—For commercial statistics see report for operating and care of canals, etc., Great Kanawha River, West Virginia.

REPORT OF MR. ADDISON M. SCOTT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1897.

MAJOR: I have the honor to submit the following report on improving Great Kanawha River, West Virginia, for the fiscal year ending June 30, 1897:

The principal work during the year has been at continuing the construction of Locks and Dams Nos. 9, 10, and 11, the last three of the project required to complete the slack-water improvement to the mouth of the river.

LOCK AND DAM NO. 9.—CONTRACT FOR FOUNDATION AND MASONRY.

For movable dam 25 miles from mouth of river and 33 below Charleston: Work on this contract with Zimmerman, Truax & Sheridan was begun in June, 1893. The masonry of the lock was completed, except a part of the coping, at the beginning of the year (July 1, 1896), and operations during the past year have been mainly on the foundations for the dam.

During the year the masonry and foundations for the navigation pass and center pier have been finished, the cofferdam removed, the cofferdam for the weir and abutment built, and some progress made on the foundation for the weir. The stone for the weir and abutment was mostly quarried and cut during the year.

Navigation pass and center pier.—At the beginning of the year, as shown by the report for 1896, work inside the cofferdam for the navigation pass and center pier was well under way. But little was accomplished in the river in July owing to high water, the cofferdam being flooded twice during the month. The current in the first rise, July 9 (highest point 24.10 feet above low water), was very swift and did some damage to the cofferdam and pumping machinery. The water fell so that the pumps were started again July 20, but the work was flooded again on the 23d by backwater from the Ohio, that reached 23 feet on the gauge at No. 9. The water kept up so that the cofferdam could not be pumped out again until August 8. From that time until October 1 work inside the cofferdam went on without interruption. During this time the wicket and bridge anchorage was finished, the last of the concrete put in, the masonry, including the center pier and the apron and guard sill of the pass, completed, the timberwork and wicket sill nearly finished, and the fixed irons, trestle and horse boxes, hurters, slides, etc., nearly all placed.

The cofferdam was flooded by a rise in the river on October 1. The river went down so that the pumps were started again October 6 and work inside resumed on the 8th. The wicket sill was finished and the last of the fixed irons placed on October 10. The bulkheads at the ends of the pier to form connections with and make part of the cofferdam for the weir were finished October 20, completing the contractors' work in this cofferdam.

The removal of the navigation-pass cofferdam was begun on October 21. Before this the movable parts of the pass, consisting of the bridge trestles, wicket horses and props, and the wickets, were placed by the United States by hired labor, which will be reported under another head.

The main features of this work are described in former reports of the Chief of Engineers. The navigation pass, like the others on the river, except No. 11, is 248 feet long. It is closed by 62 Chanoine wickets, that have a vertical height of 13 feet above the sill, operated by a service bridge. The foundations of the pass rest on rock from 7 to 9 feet below low water. The bridge and wicket anchorage reaches about 5½ feet below the average surface of bed rock, the anchor disks being placed in ditches (made by a steam channeler and blasting) that were filled with concrete.

Cofferdam for weir and abutment.—As before stated, the removal of the pass cofferdam began October 21. Two dredges were employed at this. Dredging for the cofferdam for the weir and abutment was begun November 18, and the first coffer crib was sunk on the 22d. The work was a good deal delayed by high water in November and December. On January 25, when work in the river was stopped by cold weather and ice and operations suspended for winter, this cofferdam was nearly completed. Work on the cofferdam was resumed this spring on April 22, and was completed, including the repair of some damage by high water and ice, during the winter, so that the pumps were started April 29.

The weir at No. 9 will be 284 feet long. The cofferdam extends from the center pier to the left bank and incloses the site for the weir, shore abutment, and abutment crib. The cofferdam is the same in general construction as built for the lock and the pass (see report of Chief of Engineers, 1894, p. 1955, and report for 1896, p. 2251). The cribs are 12 feet wide. The top of the cofferdam is 9 feet above low water and about 17 feet above bed rock.

Weir foundation.—Owing to high water, but little was accomplished inside the weir cofferdam until late in May. The pumps were started again May 23; excavation inside began the 25th. The first stone for the weir walls was set June 2. Placing the anchorage for the weir wickets began June 7, and the first concrete for the core of the weir was put in on the 11th.

The bed rock at the site of the weir is a hard sandstone, quite uneven, and considerable work is required to prepare it for the bottom course of the walls. Up to this time the foundation of the walls as prepared varies from about 6½ to 9½ feet below low-water mark.

Work in the cofferdam was considerably interfered with by high water in June. At present the bottom course of the weir walls is in about 130 feet out from the center pier, and considerable progress has been made in setting the other courses on this part of the walls. Fourteen anchor bolts and disks have been set, and the concrete core is in 44 feet out from the pier.

Unless interrupted too much by high water, it is thought work inside this cofferdam, and the remainder of the bank protection to be placed, will be finished not later than November 15. If this is done, the cofferdam should be removed and the contract completed before the expiration of the contract time, December 31, 1897.

The lock.—The work done on the lock during the year consisted in finishing the coping, drilling for and placing the dowels in same, and setting about 70 yards of paving on the slope and guard cribs. There is still some grading and riprapping to be done on this contract below the lock.

LOCK AND DAM NO. 10—CONTRACT FOR FOUNDATION AND MASONRY.

For movable dam 19 miles from mouth of river and 39 miles from Charleston: Work under this contract with Zimmerman, Truax & Sheridan was begun in 1893. The masonry of the lock was completed, except part of the coping, at the date of the last annual report, and operations during the year have been mainly on the foundations for the dam.

During the year the masonry and foundations for the navigation pass and center pier have been completed, the cofferdam removed, the cofferdam for the weir and abutment built, and a beginning made on the foundations of the weir. The stone for the weir and abutment were mostly quarried and cut during the year.

Navigation pass and center pier.—At the beginning of the year, as shown by the report for 1896, some progress had been made inside the cofferdam on the foundations and anchorage of the pass. The delay from high water in July and the first part of August has been referred to under the head of Lock 9. There was still more delay from this at No. 10, owing mainly to the greater effect of back water from the Ohio, and scarcely anything was accomplished inside the cofferdam until August 14; from that date until October 1 work on the foundation went forward without interruption. The cofferdam was flooded by a rise in the river October 1. The pumps were started again October 6 and work inside resumed on the 8th and was in progress until the 15th, when it was again interrupted by a rise of the river. Work was resumed on the 18th. The masonry of the pass was finished October 22, and the timber work and placing of the fixed irons, completing the contractors' work on the pass, on the 25th.

The foundations of this pass rest on rock from 5.80 to 6.80 feet below low-water mark. The elevation of bed rock at the site, the anchorage, etc., are generally described in the last annual report. The trench, channeled and blasted in the rock for the wicket-sill anchorage, was from 8 to 10 feet deep. The rock was full of seams, carrying water, and it took two 4-inch steam pumps to keep the trench dry enough to place the anchorage (cast disks and 1¼-inch bolts) and concrete. The bridge trestles were anchored by 1¼-inch diameter wedge bolts from 7 to 11 feet long, the lengths being adjusted to reach solid places in the rock.

As before stated, the contractors' work on the pass foundations, including the placing of the fixed irons, was completed October 25. Between this and October 30, the movable parts of the pass, consisting of the wicket horses and props, the wickets, and bridge trestles, were put in place by hired labor. This will be reported under another head.

The bulkheads at the ends of the center pier to form connections with the cofferdam for the weir were built the last of October, before the pumps were stopped in the pass cofferdam.

Cofferdam and weir and abutment.—The pass cofferdam was nearly all removed in November. After this, operations in the river were suspended for winter. Dredging at the site of the cofferdam for the weir was begun April 27, and the first crib for this cofferdam was sunk the next day. Work on the cofferdam was stopped by high water May 2 and could not be resumed until the 21st. The cofferdam was far enough advanced to admit of starting the pumps June 6.

The weir at No. 10 will be 248 feet long. The cofferdam extends from the center pier to the left bank and incloses the site of the weir, shore abutment, and abutment crib. It is built of rough cribs, sheathed, filled and banked, like the other cofferdams on the work. The cribs are 11 feet wide. The top of the coffer is 9.60 feet above low water, and 13 to 14 feet above bed rock on which it rests.

Weir Foundations.—Excavation inside the weir cofferdam began June 7, and was in progress during the month when not stopped by high water. The cofferdam was flooded by a rise on the 18th that reached 19 feet above low-water mark. The water went down so that the pumps were started again on the 24th and excavation inside resumed on the 26th. The bed rock is now prepared for the bottom course of the weir walls a short distance out from the pier, and setting masonry and placing anchorage and concrete will soon begin. The rock so far as exposed is about the same character as at the site of the pass. The top is broken and seamy so much in places that from 2 to 3 feet of it has to be removed to get a suitable foundation for the walls. The bottom of the anchorage ditch will run from about 2 to 5 feet below the top of the rock as found.

With a fair season for work in the river, work in this last cofferdam should be finished this fall, and the contract completed before the expiration of the present contract time, December 31, 1897.

The lock.—The work on the lock during the year consisted in finishing the coping on the main walls, and in drilling for and placing the dowels in the coping. In addition, 564 cubic yards, altogether, of stone filling, riprapping, and paving were added to the flap and slope back of the lock. There is some grading and riprapping yet to be done on this contract back of and below the lock.

LOCK AND DAM NO. 11—CONTRACT FOR FOUNDATIONS AND MASONRY.

For movable dam 1¼ miles from mouth of river, 56½ miles from Charleston, W. Va., and 88¾ miles from head of slack water. Work on this contract with Thomas Munford was begun in July, 1893. The masonry of the lock was completed, except a part of the coping, on July 1, 1896, and operations during the past year have been mainly on the foundations for the dam.

Navigation pass and center pier.—As shown by the last annual report, work inside the cofferdam for the navigation pass and center pier was well advanced on July 1, 1896. The delay caused by high water in July and August has been referred to above in connection with reports on Locks 9 and 10. There was still more delay from this at No. 11, owing to back water from the Ohio. There were only four days in July when work could be carried on in the cofferdam, and in August the water did not get low enough to admit of starting the pumps until the 18th. Work in the cofferdam was resumed August 22, and was pushed with a large force of men up to September 10, when the contractor's work on the pass foundations, including the placing of the fixed irons, was completed. The timber bulkheads at the ends of the center pier to form connections with the cofferdam for the weir were finished September 14, completing the contractor's work inside this cofferdam. After the completion of the work on the foundations, and before the removal of the cofferdam was begun, the movable irons, consisting of the bridge trestles, wicket horses, and props, and 60 of the wickets, were put in place by hired labor. This will be reported under another head.

The foundations of this navigation pass are described and illustrated in the last annual report. The work rests on hardpan, a hard indurated clay, about 20 feet below low-water mark. The pass is 304 feet wide, and is closed by 76 Chanoine wickets that have a vertical height of 13 feet above the sill. The wickets, like all the other movable dams on the river, are to be operated from a trestle service bridge.

The cofferdam for the weir.—The removal of the pass cofferdam with dredges was begun September 14 and was finished before the end of the month. Dredging for the cofferdam for the weir and abutment was begun September 28, but was stopped the next day by a rise in the river. High water, largely back water from the Ohio, in October and November interfered much with building the weir cofferdam, and there were only about twenty-two days in the two months that the water was low enough for the work. Operations in the river were suspended for the season November 28. At that time the upper and lower lines of the coffer were built out 220 feet from the abutment shore, leaving 140 feet on each line to close to connect with the bulkhead cribs at the center pier. High water this spring prevented a resumption of work on the cofferdam until May 26. After this, the work was energetically carried on, the dredges working to a considerable extent both day and night. The last coffer crib was sunk June 5. The banking and filling of the coffer (an extensive work owing to the depth of foundations at this site) was much interrupted by high water, but has been pushed with a large force whenever possible, and is now nearly completed.

The cofferdam is of the same plan as used for the lock and navigation pass. (See Report of Chief of Engineers for 1896, p. 2253.) The weir will be 364 feet long. The cofferdam extends from the center pier to the right bank, inclosing the site for the weir, abutment, and abutment crib. The top of the cofferdam is 9½ feet above low water; the bottom is on the hardpan from 17 to 18 feet below low water, making the cofferdam about 27 feet high.

The work inside this last cofferdam constitutes about all remaining to be done on the contract. The contractor is prepared to push the work, and unless it is interrupted too much by high water this summer and fall, it is probable that the contract will be completed within the time allowed—December 31, 1897.

The lock.—The work done on the lock during the year consisted in finishing the coping of the main walls and in drilling for and placing the dowels in same. There is still some grading and riprapping to be done on the bank below the lock under this contract.

MISCELLANEOUS WORK.

Iron work for weirs.—This contract with the Youngstown Bridge Company, of Youngstown, Ohio (approved February 15, 1896), for the iron work for weirs of Dams Nos. 9, 10, and 11, and the maneuvering winches for these three dams, was completed in April. The contract covered both the fixed and movable irons for the weirs and aggregated as follows, viz: Wrought iron, 318,186 pounds; cast iron, 248,892 pounds; drift bolts, 21,343 pounds, and the three maneuvering winches complete.

Timber for lock gates and wickets.—This contract with George M. Donaldson (approved January 16, 1896), for furnishing and delivering the white-oak timber required for the lock gates and wickets of Locks and Dams Nos. 9, 10, and 11, was completed in December. It aggregated 278,160 feet B. M.

Irons for lock gates.—The drawings and specifications for the iron work for the gates of Locks 9, 10, and 11 were prepared, the work advertised, and contract made by Colonel Hains with the lowest bidder, the Fort Pitt Bridge Works of Pittsburg, by agreement approved January 2, 1897. The contractors pushed the work rapidly from the beginning, and the last of the irons, completing the contract, were delivered at the locks May 3. The contract aggregated 146,718 pounds of wrought iron; 92,410 pounds of cast iron; 3,887 pounds of high and cast steel, and 936 pounds of bronze.

Building wickets and gates.—A small force of carpenters was kept employed during the year either at building wickets or lock gates by hired labor for Locks and Dams 9, 10, and 11. Except 53 weir wickets yet to build at No. 10, the navigation pass and weir wickets for the three dams have been built (except the panel plank yet to be placed) and ironed off. At Lock 9 the building of the gates is well advanced. Two of the gates at that lock are completed and ironed ready to launch and the third is nearly so. The fourth gate is assembled and partly ironed. It will take about ten more working days to get the No. 9 gates ready to launch. The gates for Locks 10 and 11 will be built next, in order named. As indicated above, the materials for the gates—timber and iron work—are all on hand at the sites.

Placing movable irons and wickets.—As noted above, under the heads of Locks 9, 10, and 11, the movable irons for the navigation passes of these three works, consisting of the service-bridge tressels and the wicket horses and props, were put in place inside the cofferdam by hired labor after the completion of the contractors' work on the foundations. All of the pass wickets, except 16 at No. 11, that had not been built, were also placed. The wickets are complete except the panel plank yet to be put in. The chains for the wickets and trestles and the aprons forming the walks of the bridges are also to be added when the dams are completed and put in operation. After the movable parts were in place, photographs were taken inside the cofferdams showing the wickets and trestles in different positions. Copies of some of the best of these photographs, with descriptions, accompany this report.

Dredging, etc.—Owing in part to high water during the ordinary working season, and partly to lack of funds for expenditure outside of contracts, only a limited amount of work was done by the Government dredge on the "improving" account. The following is a summary of this work done during the year, it being original dredging to widen and deepen the permanent towing channels in the pools. Considerable was also done with the dredge at removing deposit from lock chambers and approaches and from previously made channels in the pools, which is reported under the head of operating and maintaining the completed works.

From July 1 to 7 the dredge was working at Lock 10, when the stage of water would permit, removing an old chute wall between the end of the cofferdam for the navigation pass and the left shore. The dredge crew and part of the crew of the towboat were furloughed without pay July 9 and the dredge laid up, the water being too high to work. For reasons above given, no more dredging was done until September 2. From September 8 to 17, inclusive, was spent in reducing to miter-sill depth some high places at the head of Red House Shoal, 3 miles below Lock 8. In addition, about five days were spent at original dredging in widening the towing channel through some reefs near Plymouth. From October 5 to 24, inclusive, the dredge and towboat worked near Lock 10, removing old chute walls ("Debby," "Pike City," etc.) and reducing reefs to change the towing channel to the navigation pass. In November, seven days were spent in moving to and taking out the remainder of the Pike City wall below the pass at Lock 10. On November 30, the water being too high for work, the crews were, as far as practicable, furloughed without pay and the dredge laid up for the winter. The only dredging done so far this season has been on "operating," reported under that head. About 12,000 cubic yards of original material was dredged and moved in dump boats during the year. In connection with, but in addition to, this dredging to make new channels, the boats' crews, working mainly with the crane boat, removed 108 large stones and took out 21 sunken trees and snags.

Assistants and inspectors.—The engineering and inspecting force on construction remained about as it was the year before. Mr. Thomas E. Jeffries continued as assistant engineer and head inspector on Lock and Dam No. 11, and Mr. Albert M. Campbell in the same capacity on Lock and Dam No. 10. Both were engaged in this office during the winter and early spring, when not required at the locks, mainly on detail drawings of the works under construction. W. W. Venable was employed as assistant engineer on Lock and Dam No. 9 during the working season. R. M. Stephens, S. G. Campbell, and J. R. Myers continued as assistant inspectors on Locks and Dams 9, 10, and 11, respectively. Mr. Myers was employed from January 19 to May 1 as inspector in the shop on the contract for irons for lock gates, and C. E. Gardner continued as inspector in the shop on the iron work for weirs until the completion of work on that contract in March. J. S. Williams, master carpenter, was employed inspecting timber and building the wickets and gates for Locks and Dams Nos. 9, 10, and 11.

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

F F 11.

OPERATING AND CARE OF LOCKS AND DAMS ON GREAT KANAWHA RIVER, WEST VIRGINIA.

[This work was in the charge of Col. Peter C. Hains, Corps of Engineers, until April 30, 1897.]

The finished locks and dams in this stream, i. e., Nos. 2, 3, 4, 5, 6, 7, and 8, were built under the appropriation for improving Great Kanawha River, West Virginia. Their location, etc., and also that of Nos. 9, 10, and 11, now under construction in the lower part of the stream under the appropriation for improving Great Kanawha River, is shown on page 2247, Annual Report of the Chief of Engineers for 1896, part 4.

For details of the work done during the past fiscal year, and in operating and caring for the two finished locks (Nos. 2 and 3) with fixed dams, in the upper part of the river, and the five finished locks (Nos. 4, 5, 6, 7, and 8) with movable dams, below Nos. 2 and 3, attention is invited to the report of Mr. Addison M. Scott, assistant engineer, herewith.

The amount expended during the past fiscal year in operating and caring for the finished works, and in maintaining channels originally dredged between locks under the appropriation for improving Great Kanawha River, was $26,868.30.

REPORT OF MR. ADDISON M. SCOTT, RESIDENT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., June 30, 1897.

MAJOR: I have the honor to submit the following report on operating and keeping in repair the completed works in the Great Kanawha River for the fiscal year ending June 30, 1897.

With the exception of the accident in December to the service bridge of Dam No. 7, reported below, the seven completed locks and dams remained in good working order throughout the year. As usual, a good deal was done at each of the locks by the regular hands in keeping the works in order and repair. Some of the most important items of repairs during the year are reported below.

FIXED DAMS.

Locking was suspended at the two fixed dams (Nos. 2 and 3) fourteen days by ice, and six and one-half days by high water during the year.

At Lock No. 3 quite a job of riprapping was done to repair and extend the bank protection below the works, both on the lock and abutment sides. In doing this about 712 cubic yards of new stone were placed, and a large quantity of earth moved to grade the banks. Four hundred and five yards of this riprap stone were purchased (furnished and delivered on top of the bank) after circular letter advertisement, the remainder being nearly all boated from a bar below the dam. In addition, about 800 cubic yards of small bowlders and gravel were moved during low water last fall in reducing a bar to better the direction of the current below the lock. This work was all done by the regular lock hands, assisted by some hired labor.

MOVABLE DAMS.

Owing to frequent fluctuations in the river during the ordinary low-water season the five movable dams were raised and lowered more than usual during the year. Except the damage to the service bridge at Dam No. 7, reported below (which prevented keeping that dam up on about 29 days), the maneuvers were all successfully made. Considerable trouble was experienced at the dams, particularly those below Charleston, from drift carried in from side streams by local rains. This has caused the lockmen a great deal of hard work, sometimes extending into or through the night, and has made it necessary at times to employ extra labor. In the first raising of the dams this spring much more than the usual amount of deposit was found on the works—in the lock chambers and approaches and on the foundations of the navigation passes.

The maneuvers of each dam, giving time taken, principal difficulties encountered, etc., are reported in tabular form below:

Lock and Dam No. 4.—This dam was kept up one hundred and eighty-one days during the year and down the remainder of the time, owing to high or sufficient stages of water. Fifteen new wickets were built for the weir. With this exception only ordinary repairs were made at No. 4 during the year.

The dam was maneuvered as follows:

Maneuver.	Date.	Time taken.		Men employed.	Remarks.
		h.	*m.*		
Raised	July 8	4	0	5	No difficulty.
Lowered	July 9	1	30	6	Do.
Raised	July 20	7	30	5	Delayed 30 minutes by foul chains.
Lowered	July 27	1	30	6	No difficulty.
Raised	July 30	5	30	5	Do.
Lowered	July 31	1	0	6	Do.
Raised	Aug. 7	5	0	5	Do.
Lowered	Sept. 30	1	0	6	Do.
Raised	Oct. 6	6	0	6	Do.
Lowered	Nov. 5	1	30	6	Do.
Raised	Nov. 15	5	30	6	Delayed 30 minutes by foul chains.
Lowered	Nov. 29	1	0	5	No difficulty.
Raised	Dec. 8	5	30	6	Do.
Lowered	Dec. 9	1	30	6	Do.
Raised	Dec. 28	5	30	6	Do.
Lowered	Jan. 25	1	30	6	Do.
Raised	April 24	8	0	6	Delayed 45 minutes by foul chains.
Lowered	May 2	1	30	6	No difficulty.
Raised	May 24	4	30	6	Do.
Lowered	June 20	1	30	6	Do.
Raised	June 26	5	30	6	Do.

Lock and Dam No. 5.—This dam was kept up one hundred and seventy-six days during the year. In addition to ordinary work and repairs, the wickets of the pass and weir were overhauled and new panels, etc., put in where needed; two new pass wickets were made. Timber has also been procured for considerable repairs to the guard cribs of the lock.

The dam was maneuvered as follows:

Maneuver.	Date.	Time taken.		Men employed.	Remarks.
		h.	*m.*		
Raised	July 8	9	0	4 to 5	Delayed 30 minutes by broken trestle chains.
Lowered	July 9	1	15	4 to 6	No difficulty.
Raised	July 21	12	0	5 to 6	Delayed about 2½ hours by sediment of trestle bed, foul chains, and tripping bar off guides.
Lowered	July 26	1	10	4 to 6	No difficulty.
Raised	July 30 to 31	14	0	6	About 7 hours spent in removing a broken twin box and putting in a new one.
Lowered	July 31	1	10	4 to 6	No difficulty.
Raised	Aug. 7	9	30	6	Delayed by tripping bar off guides.
Lowered	Sept. 30	1	30	4 to 5	No material difficulty.
Raised	Oct. 7	9	20	5	Delayed 45 minutes by broken chains and 2 hours placing tripping bar on guide.
Lowered	Nov. 5	2	25	5	Some delay by 2 wickets failing to trip; no material difficulty.
Raised	Nov. 15	7	30	6	No material difficulty.
Lowered	Nov. 29	1	35	3 to 6	Do.
Raised	Dec. 8	8	15	6	Do.
Lowered	Dec. 9	1	15	3 to 6	Do.
Raised	Dec. 28	8	0	6	Do.
Lowered	Jan. 25	2	30	6	Considerable trouble with ice. The tripping bar failed and 16 wickets were lowered by hand.
Raised	Apr. 24	12	0	5 to 7	First raising this spring; delayed principally by sediment on pass foundations.
Lowered	May 2	2	15	6	No material difficulty.
Raised	May 24	7	0	5 to 6	No difficulty.
Lowered	June 20	2	0	6	No material difficulty.
Raised	June 25	8	20	6	No difficulty.

Lock and Dam No. 6.—The dam was kept up one hundred and seventy-three days during the year and down the remainder of the time, owing to high or sufficient stages in the river.

In addition to ordinary work and repairs at No. 6, the following is noted: In a partial raising of the service bridge July 22 the fastening broke that held the maneuvering winch to the track and let the winch into the river. It was badly broken by the fall. An extra winch was used while the broken one was repaired, and no delay was caused at the dam. This was the second accident of the kind that has occurred on the river. To avoid this in future the winches are now secured to the track by two fastenings when raising the trestles.

On December 4, as fully reported for that month, a coal fleet in running the pass struck a wicket that proved to be not entirely down (the dam had been lowered on the night of November 28), breaking the wicket and horse and bending the prop. This caused no delay in maneuvering the dam, except a few hours required to remove the broken wicket and horse and place others. While lowering the dam for a rise in the river the night of June 19 a sudden "run out" from Elk River, bringing a number of runaway rafts, a large quantity of loose logs, ties, and drift prevented the lowering of the pass wickets. The weir and all of the service bridge were put down safely. The river fell, so that the wickets were lowered uninjured, after considerable work in clearing the wickets and horses of drift, on June 22 and 23. Fortunately the river did not get high enough when the wickets were up to interfere with the use of the lock.

The dam was maneuvered as follows:

Maneuver.	Date.	Time taken.		Men employed.	Remarks.
		h.	*m.*		
Raised	July 3	10	00	4 to 5	No difficulty.
Lowered.	July 9	3	30	4	No difficulty; lowered slowly, by orders, to keep up pool.
Raised	July 30	11	15	5 to 6	Delayed 6½ hours by foul chains.
Lowered	July 31	1	05	5	No difficulty.
Raised	Aug. 7	10	0	4 to 6	Do.
Lowered	Sept. 30	4	30	5	Lowered slowly to keep up pool; no difficulty.
Raised	Oct. 6	9	0	5	No difficulty.
Lowered	Nov. 5	4	30	6	No difficulty; lowered slowly to keep up pool.
Raised	Nov. 15	6	30	6	No difficulty.
Lowered	Nov. 29	4	0	6	No difficulty; lowered slowly to keep up pool.
Raised	Dec. 8	8	30	5	Delayed one hour and a half by broken wicket.
Lowered	Dec. 9	1	0	6	No difficulty.
Raised	Dec. 29	10	30	6 to 7	Delayed 1 hour by foul chains and 2½ hours to remove broken pass horse.
Lowered	Jan. 25	8	0	5	No material difficulty.
Raised	Apr. 26 to 27	21	40	4 to 5	First spring raising. Delayed some by sediment in pier recess, etc., and about 7 hours putting in new wicket and horse in pass.
Lowered	May 2	2	0	6	No difficulty.
Raised	May 24	8	0	6	No material difficulty.
Lowered	June 20 and on 22 and 23.				See report above.
Raised	June 28	8	0	6	No material difficulty.

Lock and Dam No. 7.—The dam was up one hundred and forty-five days during the year. It wonld have been up about twenty-nine days longer but for the accident reported below.

The dam was maneuvered as follows:

Maneuver.	Date.	Time taken.		Men employed.	Remarks.
		h.	*m.*		
Raised	July 3	12	0	6	Delayed 2½ hours by sediment on foundations and drift under pass trestles.
Lowered	July 9	4	10	6	Some delay by drift.
Raised	July 21	9	40	5 to 6	No material difficulty.
Lowered	July 24	4	40	4 to 5	Delayed 1 hour by drift and 1 hour and 20 minutes by bent trestle.
Raised	Aug. 8	8	10	4 to 6	Delayed one-half hour straightening trestle and 1½ hours by drift under wickets.
Lowered	Sept. 30	2	20	4 to 5	No difficulty.
Raised	Oct. 6	5	25	4 to 6	Do.
Lowered	Nov. 5	5	35	3 to 4	No difficulty; lowered slowly by orders to keep up pool.
Raised	Nov. 15	8	15	6	No difficulty.
Lowered	Nov. 28 to Dec. 9			4 to 8	See report below.
Raised	Apr. 25 to Apr. 30	58	0	5 to 9	Greater part of time spent in putting in trestles damaged December 3. Some delay by sediment on pass foundations, etc.
Lowered	May 2	0	50	6	No difficulty; weir all down at beginning of maneuver.
Raised	May 24	8	30	4 to 6	Delayed two hours by deposit on trestle bed, etc.
Lowered	June 20	4	30	3 to 6	No material difficulty.
Raised	June 28	7	15	5 to 6	No difficulty.

Principal repairs, etc.—In addition to ordinary work and repairs at No. 7 the following is noted: In lowering the dam on the night of November 28, a sudden rise in Coal River (this stream comes in about 1¼ miles above No. 7) brought out a large quantity of heavy drift. The lockmen delayed too long about lowering the pass, and so much drift accumulated against the pass trestles that nine of them could not be put down. Some of the drift was removed and the trestles got part way down by December 1. On December 3, the river having fallen some, the fouled trestles were pulled up, with five others near the lock, to clean out the drift and lower the trestles to place. While this was in progress the towboat *Winifrede* came down with three loaded coal barges; she started to land at the head of the lock to be locked through, but before her lines were secured the strong current around the head of the river wall and through the pass swung the steamer out from the shore. She was unable to hold the tow, and steamer and barges together were carried down against the standing trestles. Twelve of the trestles were bent and broken, some of them being badly wrecked. In addition, twelve bridge aprons were bent or broken, four rails injured and five lost in the river. One of the coal barges was sunk alongshore below the dam out of the way of navigation and another was considerably damaged, by striking the trestles. Capt. D. D. Stout, the owner of the *Winifrede*, was at the wheel at the time. He is one of the most careful and skillful towboat men on the river. It is true a mistake was made in not promptly getting out lines to hold the tow. The conditions, however, in landing at the head of the lock in such a strong current were unusual, almost unprecedented, and it seemed plain, all considered, that no one was really blamable for the accident. The broken trestles were taken out, and after being repaired replaced by divers. Seven of them that had to be rebuilt, requiring new channel iron throughout, were repaired in a Charleston shop. The remaining five, and all of the injured aprons, were repaired mainly by the lockmen in the blacksmith shop at the site. The total cost of repairs to the work due to the accident, aside from the work done by the regular hands, was about $436.

High water during the winter washed the bank considerably below the abutment. In repairing this this spring, about 1,200 cubic yards of earth were removed to grade and seed the slope, and 105 yards of riprap stone, from the stock on hand, placed.

Lock and Dam No. 8.—This dam was kept up one hundred and fifty-two days during the year and down the remainder of the time, owing to high or sufficient stages of water.

The maneuvers of the dam during the year were as follows:

Maneuver.	Date.	Time taken.		Men employed.	Remarks.
		h.	*m.*		
Raised	July 3	7	0	5 to 6	No material difficulty.
Lowered	July 9	4	30	6	Delayed about 2 hours by drift and weir aprons not going down well.
Raised	August 10	10	0	5 to 6	No material difficulty.
Lowered	September 30	4	15	6	Delayed 1 hour and 40 minutes by drift.
Raised	October 12	8	15	3 to 7	Delayed 1 hour by foul chains.
Lowered	November 5	5	0	3 to 7	Delayed about 1 hour by drift.
Raised	November 16	11	30	5	No material difficulty.
Lowered	November 28	2	30	5 to 6	Do.
Raised	December 28	7	0	3 to 6	Do.
Lowered	January 25	3	30	6	Delayed about 1 hour by ice and drift.
Raised	April 30	10	30	5 to 7	Delayed about 2 hours by drift under pass wickets, etc.
Lowered	May 2	0	45	5	No difficulty; weir all down at beginning of maneuver.
Raised	May 25	7	45	4 to 6	No material difficulty.
Lowered	June 20	3	20	5 to 6	Delayed 1 hour by drift. No material difficulty.
Raised	June 28	7	30	6 to 7	No material difficulty.

DREDGING, ETC.

The Government dredge, assisted by the towboat *Bee*, was employed as far as required during the year in maintaining existing navigation by removing sediment and obstructions from the approaches and made channels. The following is a summary of work under that head: About two days were spent in July dredging deposit from the lower approach of Lock No. 8. As reported under improvement of the river, the dredge was laid up from July 9 to September 1. In September eleven and in October four working days were spent in dredging out deposit from the lower approach of Lock 8 and the made channels between Lock 8 and Plymouth. From October 25 to November 23, working at Lock 3, dredging deposit from lower approach and from channel between the lock and the head of Harvey Shoal. The dredge was laid up for winter November 30. Dredging was begun this season June 7 in the lower approach of Lock 6. This was finished June 10, and the boats moved to the head of No. 6 pool, where they worked from the 11th to the 16th, tearing out the remnant of a wrecked coal barge near the mouth of Lens Creek, and in removing a "bank slip" near the lower approach of Lock 5. From June 17 to 19 dredging out the lower approach of Lock 2. The river was too high to work June 20, 21, and 22. From the 23d to the end of the month dredging deposit from made channels below the lower approach at Lock No. 4.

Besides the dredging reported, but mainly in connection with it, the crews of the dredge and towboat working with the crane boat and dredge, took from the channels and approaches 120 large stones and 36 snags and sunken trees. The side wall of the Red House chute was also built up and repaired in September, with the assistance of some hired labor; in doing this, about 1,200 cubic yards of large stone were handled and replaced on the wall.

The most important repairs on the boats during the year consisted in docking and calking the crane boat, fuel boat, and one dump boat, and in docking, calking, and making considerable repairs to the hull of the towboat.

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

Statement of expenses during the fiscal year ending June 30, 1897, out of the general appropriation for "operating and care of canals and other works of navigation," in operating and keeping in repair the locks and dams on the Great Kanawha River, West Virginia.

Lock and Dam No. 2:		
Wages of regular lock hands	$2,085.83	
Repairs and extra labor	25.85	
Supplies, as paints, oils, fuel, tools, etc	31.59	
Freights and transportation	2.50	
		$2,145.77
Lock and Dam No. 3:		
Wages of regular lock hands	2,065.34	
Repairs and extra labor	447.73	
Supplies, as paints, oils, fuel, tools, etc	37.40	
Freights and transportation	5.50	
		2,555.97
Lock and Dam No. 4:		
Wages of regular lock hands	2,172.00	
Repairs and extra labor	223.35	
Supplies, as paints, oils, fuel, tools, etc	47.79	
		2,443.14
Lock and Dam No. 5:		
Wages of regular lock hands	2,213.50	
Repairs and extra labor	364.34	
Supplies, as paints, oils, fuel, tools, etc	48.48	
Freights and transportation	5.90	
		2,632.22
Lock and Dam No. 6:		
Wages of regular lock hands	2,279.34	
Repairs and extra labor	301.60	
Supplies, as paints, oils, fuel, tools, etc	55.66	
Freights and transportation	2.00	
		2,638.60
Lock and Dam No. 7:		
Wages of regular lock hands	2,154.42	
Repairs and extra labor	691.80	
Supplies, as paints, oils, fuel, tools, etc	51.37	
Freights and transportation	13.15	
		2,910.74
Lock and Dam No. 8:		
Wages of regular lock hands	2,196.57	
Repairs and extra labor	797.54	
Supplies, as paints, oils, fuel, tools, etc	49.58	
Freight and transportation	1.25	
		3,044.94

Superintendence and central office expenses:		
Wages	$3,540.04	
Rent and supplies	357.31	
Freights and transportation	19.72	
		$3,917.07
Dredging and running expenses of towboat:		
Wages	2,649.43	
Repairs and supplies	1,240.09	
Freights and transportation	3.07	
		3,892.59
Launch *Mascot*:		
Wages	420.00	
Repairs and supplies	69.86	
		489.86
Telephone line:		
Rent of instruments	16.00	
Repairs and supplies	19.38	
Freights and transportation	3.60	
		38.98
Gauge reports:		
Pay of gauge keepers and reporters at Hinton and Kanawha Falls	149.62	
Repairs and supplies	8.80	
		158.42
Total		26,868.30

COMMERCIAL STATISTICS.

UNITED STATES ENGINEER OFFICE,
Charleston-Kanawha, W. Va., July 22, 1897.

Statement of number of tons of coal, including that manufactured into coke, shipped by river from mines on the Great Kanawha, for the several years named.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1875	161,932	1886	714,465	1892	1,071,511
1876	200,962	1887	929,335	1893	919,320
1877	207,346	1888	804,025	1894	1,032,840
1881	385,148	1889	1,076,872	1895	879,304
1883	614,818	1890	966,462	1896	922,000
1884	736,843	1891	1,030,454	1897	848,600
1885	712,493				

Tonnage of the Great Kanawha River for the year ending June 30, 1897.

Articles.	Quantity.	Tonnage.	Articles.	Quantity.	Tonnage.
Coal ... bushels	21,215,000	848,600	Shingles	1,984,000	289
Timber ... feet B. M.	30,537,000	50,895	Brick	98,500	245
Staves, oak	68,500	514	Salt ... barrels	2,143	300
Bark and wood for tanning ... cords	5,050	9,595	Merchandise and produce in steamboats		49,035
Hoop poles	555,600	1,389			
Railroad ties, oak	1,093,150	163,972	Total		1,124,843

Total annual tonnage for the several years named.

Year.	Tons.	Year.	Tons.	Year.	Tons.
For 1890	1,127,232	For 1893	1,116,537	For 1896	1,162,782
For 1891	1,225,355	For 1894	1,222,530	For 1897, as above	1,124,843
For 1892	1,360,750	For 1895	1,082,342		

Respectfully submitted.

ADDISON M. SCOTT, *Resident Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

Commerce passing each of the seven finished locks and dams in Great Kanawha River, West Virginia, during the fiscal year ending June 30, 1897.

Articles.	Lock No. 2.	Lock No. 3.	Lock No. 4.	Lock No. 5.	Lock No. 6.	Lock No. 7.	Lock No. 8.
Coal.................bushels..	1,506,000	2,851,000	7,330,000	9,522,100	14,671,500	14,893,600	20,494,000
Coke.....................tons..	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Lumber, etc.............feet..	186,250	1,982,000	1,917,050	1,647,900	6,649,900	4,983,014	8,741,000
Shingles ....number..	170,000	178,650	870,300	1,792,850	53,000	27,000	45,000
Brick.....................do....	5,110	90,000	36,520	56,990	41,500	18,750	29,150
Miscellaneous freight..tons..	3,087	5,887	10,076	12,787	20,255	20,227	20,950
Steamboats..........number..	1,469	1,641	1,816	1,947	2,016	2,033	2,207
Coal barges.............do....	811	496	1,117	1,695	2,001	2,333	2,954
Other craft..............do....	40	78	104	123	120	155	170
Passengers ....do....	7,635	11,789	20,507	35,686	31,803	14,526	12,861
Salt.................barrels..	....	....	818	1,795	348	256	....
Railroad ties.......number..	....	....	....	....	19,000	33,125	619,150
Staves ....do....	....	....	....	....	....	7,500	7,500
Hoop poles...............do....	....	....	....	....	20,650	12,600	12,600
Lockages ....do....	1,515	1,760	914	986	993	852	943

List of stern and side wheel boats plying on the Great Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Bee	U. S. towboat	120	22	3.6	85
Mascot[a]	U. S. launch	61	8.1	3.4	7
Goldenrod	U. S. L. H. tender	150	26.5	3.7	143.58
Kanawha	Packet	185	35	4	429.07
Henry M. Stanley	do	180	32.4	5.5	293.77
Columbia	do	156	24.2	4	197.96
H. K. Bedford	do	149	27.6	4	139.68
Speedwell	do	140	25	4	149.40
Ruth	do	136.5	24.5	4.4	131.78
Kanawha Bell	do	128	24.2	4	133.50
Mountaineer	do	122	20.2	4	110.52
T. D. Dale	do	111.6	19.7	3.2	85.77
Ida Smith	do	111.6	17.9	2.6	44.14
Claribell	do	100	18.8	2	71.48
Ed. C. Kirker[b]	do	70	7	2	9.66
E. R. Andrews	Towboat	165	32.5	5.2	351.07
Convoy	do	146	26.5	3.7	170.53
William Ernst	do	140	25.2	4	197.64
Coal Bluff	do	136	24	4.4	162.14
Mount Clare	do	134.5	25.8	4.8	191.86
Iron Cliff	do	132	24	4	154.70
D. T. Lane	do	129.6	24.1	4	146.94
Geo. W. Moredock	do	126.5	25.4	3.2	148.75
Gate City	do	125	25.7	4.5	109.44
Ben Wood	do	122	23	5	143.69
Ida Budd	do	121.9	26.2	4.6	151.90
Winifrede	do	120	20	3.1	109.78
Lyda	do	120	21.4	3.4	107.90
Annie L.	do	115.8	20.8	3.1	114.69
J. M. Bowell	do	115	23	3.8	107.91
Geo. Matheson	do	112	22	4	124.06
W. B. Calderwood	do	112	24.5	4.6	85.55
Alex. Martin	do	109.4	20	3.2	57.39
R. B. Kendall	do	105	18	3	70
Ada V	do	82	18.6	2.6	23.88
Stella	do	76	16.3	2.5	20.86
G. T. Thayer	do	49	9.3	2.2	7.95
Billy Martin[a]	Pump and harbor boat	89	14.3	4	28.15
Iron Duke[a]	do	88	13.5	3.7	30.63

[a] Screw propeller.

[b] Side-wheel.

F F 12.

IMPROVEMENT OF LITTLE KANAWHA RIVER, WEST VIRGINIA.

The act of Congress of June 3, 1896, appropriated $1,500 for continuing the work in accordance with the original project, adopted in 1877, viz, removing such obstructions as rocks, snags, overhanging trees, etc., from the stream above Burning Springs, W. Va., about 40 miles above Parkersburg, so as to aid light-draft steamboat navigation and the floating of timber to market. The resumption of work with these funds has been delayed until the stream reaches a sufficiently low stage to permit the work to be done thoroughly and economically.

Money statement.

July 1, 1896, balance unexpended	$1,500.00
June 30, 1897, amount expended during fiscal year	2.54
July 1, 1897, balance unexpended	1,497.46

APPROPRIATIONS.

August 14, 1876	$7,300	August 5, 1886	$16,875
June 18, 1878	18,000	August 11, 1888	25,000
March 3, 1879	18,000	September 19, 1890	40,000
June 14, 1880	15,000	June 3, 1896	1,500
March 3, 1881	40,000		
August 2, 1882	31,000	Total	212,675

NOTE.—For list of boats plying Little Kanawha River, and commercial statistics, see report for operating and care, etc., Little Kanawha River, West Virginia.

F F 13.

OPERATING AND KEEPING IN REPAIR THE LOCK ON LITTLE KANAWHA RIVER, WEST VIRGINIA.

This lock and dam, known as No. 5, were constructed under the additional project for improving Little Kanawha River, West Virginia, of 1880, and were opened to navigation on December 2, 1891, since which time they have been operated and kept in repair under the indefinite appropriation for operating and care, etc.

During the past fiscal year Lock and Dam No. 5 have been in condition to be operated continuously, excepting on one day when an unusually high stage of water unseated one of the lock gates.

For details of the work done during the past year attention is invited to the report of Mr. B. F. Thomas, assistant engineer, herewith.

ALLOTMENTS.

1892	$1,500.00	1896	$3,378.17
1893	4,426.65	1897	830.72
1894	3,837.97		
1895	3,491.03	Total	17,464.54

REPORT OF MR. B. F. THOMAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Louisa, Ky., June 30, 1897.

MAJOR: I have the honor to report upon the operation and care of Lock No. 5, Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1897.

This lock is situated about 40 miles from Parkersburg, the mouth of the river. Below it the Little Kanawha Navigation Company has four locks and dams; but, owing to the fact that they are not kept in good repair, it is only during a wet season that navigation below Lock No. 5 is maintained with certainty.

During the past year but little work has been required at Lock No. 5.

Lock.—The wickets have worn loose on their shafts, and material and tools for repairing them have been purchased and are on the ground awaiting a suitable low stage of water in which to perform the work. These wickets have always had a tendency to self-operation, and ratchet capstans have been placed upon them so as to hold them in any desired position. This is a great improvement to them both in the saving of water and the safety of operation.

During the unprecedented high water of February one of the gates was unseated, but navigation was delayed but one day before it was replaced.

The high water also damaged the bank behind lock, and displaced considerable paving. The bank was repaired and the paving relaid.

Dam.—The dam required but little repairs, twelve new pieces of decking being placed.

Grounds.—The river bank in front of the grounds above and below the lock was graded and sowed in grass, and 100 additional shade trees were planted; repairs were made to the fences and they were whitewashed, and 300 feet of new fence were built and 200 feet rebuilt where it had been carried away by high water.

Buildings.—Wire screens were placed on all outside doors and windows of the two lock men's dwellings, and a tin roof was put on the front porch of the lock hand's dwelling; new locks were also placed on the outside doors of this house; a new outbuilding was built for each house.

Miscellaneous.—The river bank below lock cuts away a little each year and it was necessary to place 150 cubic yards riprap stone on this; the crib above lock was paved and 30 yards of stone were placed behind abutment.

Owing to the unusual amount of rainfall the lock has been in operation considerably more than heretofore and has worked with great satisfaction and facility, even with the wickets in bad repair.

Respectfully submitted.

B. F. THOMAS, *Assistant Engineer.*

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

Detailed statement of expenses incurred in preserving and maintaining navigation on that portion of the Little Kanawha River, West Virginia, improved by lock and dam, during the fiscal year ending June 30, 1897.

Month.	Salaries.	Labor and material.	Current and contingent expenses.	Total.
1896.				
July	$95.00	....	....	$95.00
August	95.00	$8.85	....	103.85
September	95.00	17.75	$41.59	154.34
October	95.00	80.60	28.43	204.03
November	95.00	391.69	18.75	505.44
December	95.00	313.80	22.30	431.10
1897.				
January	95.00	44.00	....	139.00
February	95.00	....	....	95.00
March	190.00	78.37	20.15	288.52
April	....	10.00	....	10.00
May	95.00	....	....	95.00
June	190.00	22.50	15.25	227.75
Total	1,235.00	967.56	146.47	2,349.03

Commercial statistics for fiscal years ending June 30, 1890–1897, Little Kanawha River, West Virginia.

Articles.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Coal	1,100	10,507	3,100	1,280	644	700	876	1,398
Lumber	8,540	28,677	20,486	18,720	8,552	12,450	5,009	11,887
Oil	678	1,450	1,738	666	1,230	1,960	....	....
Staves	24,500	26,964	10,050	8,470	22,113	23,000	7,160	15,420
Timber	70,000	59,703	109,337	48,386	47,250	108,000	45,987	90,000
Ties	27,650	48,312	92,200	53,500	21,923	16,420	27,446	30,634
Passengers	1,563	1,500	1,343	1,450	1,200	1,310	1,724	1,830
Miscellaneous	6,084	13,575	6,000	4,600	3,500	15,400	17,010	25,000
Total	140,115	190,688	244,254	137,072	106,412	179,240	105,212	176,169

List of boats plying on Little Kanawha River, West Virginia.

Name of boat.	Character.	Length.	Breadth.	Depth.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
Oneida	Stern-wheel	104	19.5	4.2	75.78
W. A. Hilton	do	105	22.5	3.6	67.54
Burnidina King	do	....	....	....	....
D. T. Watson (tow)	do	90	17	2.6	30.45
Mary E. (tow)	do	86	13.6	3.6	19.34
Lula F. (tow)	do	98.4	15.1	2.6	37.16

Report of lockages on the Little Kanawha River, West Virginia, for the fiscal year ending June 30, 1897.

LOCK NO. 5.

Days operated	342
Days suspended	23
Going up:	
Steamboats	291
Barges and flats	120
Miscellaneous	72
Going down:	
Steamboats	282
Barges and flats	111
Rafts	1,978
Miscellaneous	69
Total crafts and flats passing	2 923
Total number lockages	2,695

NOTE.—Suspensions for ice, five days; for high water, eighteen days.

APPENDIX G G.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE SUPERIOR.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Grand Marais, Minnesota.
2. Harbor at Agate Bay, Minnesota.
3. Harbor at Duluth, Minnesota, and Superior, Wisconsin.
4. Harbor at Ashland, Wisconsin.
5. Harbor at Ontonagon, Michigan.
6. Waterway from Keweenaw Bay to Lake Superior, Michigan.
7. Harbor at Marquette, Michigan.
8. Harbor of refuge at Presque Isle Point, Marquette Bay, Michigan.
9. Harbor of refuge at Grand Marais, Michigan.

EXAMINATION.

10. Harbor at Portwing, Wisconsin.

HARBOR LINES.

11. Superior and Allouez bays at Duluth and Superior Harbor, Minnesota and Wisconsin.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 20, 1897.

GENERAL: I have the honor to transmit herewith my annual report for the fiscal year ending June 30, 1897.

* * * * * * *

Very respectfully,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

G G 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

This harbor is an elliptical bay, whose major axis is about one-half mile and whose minor axis is about one-fourth of a mile in length. It has an opening on the south side, which was originally about 1,000 feet in width. Before improvement there was a maximum depth of 14 feet over a very limited area, the general average depth being only 8 or 9 feet. It is the only harbor of refuge on the north shore between Two Harbors (Agate Bay) and the international boundary line.

The approved project of 1879 is to build two breakwater piers, each 350 feet long, from the east and west points of the bay, or one pier 700 feet long from the east point, and dredge an anchorage area of about 26 acres to a depth of at least 16 feet, all at an estimated cost of $139,669.40. The object of this work is to provide a harbor for purposes of refuge and commerce, which it has fully accomplished as far as completed.

The improvement of the harbor commenced in 1880. At the present time the length of completed breakwater is 350 feet, or one-half of the whole, and the 16-foot anchorage is 26 acres in extent. This completes this part of the project.

This anchorage gives room for safe swinging at anchor of a few vessels only and should be increased to the full capacity of the harbor, which has an area of about 61 acres. To protect this area properly would require a further extension of the pier some 500 feet instead of 350 feet, as provided for in the present project.

The first commercial report, that of 1878, showed that 4 tugs and 5 schooners entered and departed from this harbor, making 25 arrivals and clearances in all, and doing a business of 60 tons, valued at $6,000. Last year, navigation season of 1896, the total arrivals and clearances were 402 vessels, principally steamers, with a total cargo tonnage of 1,360 tons, valued at $114,198.

Rich mineral deposits are alleged to exist in the back country. Should these be opened up and connected with the lake by railroad, the harbor may become of some importance for the shipment of ore.

The work of improvement has been carried on by contract after due advertisement. The total amount dredged to date has been 337,948 cubic yards, at an actual cost of $81,463.50, or a trifle more than 24 cents a cubic yard as an average.

The 350 feet of pier has cost $31,147 for construction and $3,205 for repairs. These figures do not include expenses of surveys, administration, and inspection, which have been nearly 15 per cent, owing to the distance of this harbor from the market for labor and material, and its isolated situation in general.

The river and harbor act of June 3, 1896, appropriated $3,000 for continuing the improvement of this harbor. This was partly expended during the present season in extending the anchorage area by dredging, under a public notice dated March 10, 1897, with Mr. Robert Smith, representing the Duluth Dredge and Dock Company, the lowest bidder. Work commenced May 18, and was completed June 1, 1897. The price was 17½ cents a cubic yard, scow measurement, or 2½ cents a yard less than under the previous contract. The material consisted of sand, gravel, and small bowlders. An inspection made June 12, 1897, showed the anchorage area to be intact and the pier in good condition, barring some slight abrasions by the ice, which can be repaired for a few hundred dollars.

Of the original estimated cost of the present approved project, $133,350 has been appropriated, requiring $6,319.40 to complete the estimate. This estimate, made back in 1879, will be insufficient to complete, due to an underestimate as to cost of piers and an overexpenditure for dredging. The dredged area has been carried out to give a navigable depth of 16 feet, whereas the estimate was originally intended for only 14 feet, although it does not so state specifically. (See report of Chief of Engineers, 1875, p. 184.)

This work is in the collection district of Duluth, Minn. Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

Money statement.

July 1, 1896, balance unexpended	$3,576.01
June 30, 1897, amount expended during fiscal year	2,847.78
July 1, 1897, balance unexpended	728.23
Amount (estimated) required for completion of existing project	6,319.40
Amount that can be profitably expended in fiscal year ending June 30, 1899	22,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

ESTIMATES.

Original amount (estimated) required to complete the improvement	$139,669.40
Amount necessary to complete the present project as originally estimated, and which can be profitably expended in next fiscal year	6,319.40

Abstract of appropriations for improving harbor at Grand Marais, Minn.

By act of Congress—		By act of Congress—	
Approved March 1, 1879	$10,000	Approved September 19, 1890	$22,350
Approved June 14, 1880	10,000	Approved July 13, 1892	10,000
Approved March 3, 1881	20,000	Passed August 7, 1894	3,000
Passed August 2, 1882	20,000	June 3, 1896	3,000
Approved July 5, 1884	10,000		
Approved August 5, 1886	10,000	Total	133,350
Passed August 11, 1888	15,000		

Expenditures.

Amount expended under approved project to June 30, 1897	$132,621.77
Balance available July 1, 1897	728.23

Abstract of proposals received at Duluth, Minn., in response to public notice, dated March 10, 1897, for dredging at Grand Marais, Minn., opened March 20, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard, scow measurement.
		Cents.
1	West Duluth Land Company, Duluth, Minn	19
2	Charles S. Barker, West Superior, Wis	24
3	Williams, Green & Williams, Duluth, Minn	20
4	Robert Smith, Duluth, Minn	17½

Bid of Robert Smith accepted. Work commenced and completed during May and June, 1897, some 13,500 cubic yards being dredged. No formal contract made.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Minn., for 1896.

Designation.	Arrivals.	Clearances.	Total.
Coastwise	121	119	240
Foreign	81	81	162
Total	202	200	402

No new lines of transportation were established.

Freight received and shipped, 1896.

	Tons.
Receipts:	
Grain	31
Flour	43
Mill stuffs	21
Coal	57
Lumber	91
General merchandise (packages of freight)	1,075
Total	1,318
Shipments:	
Fish	25
Miscellaneous	17
Total	42

Freight received and shipped for fifteen years.

Year.	Tons.	Value.	Year.	Tons.	Value.
1882	224	$25,691	1890	275	$32,035
1883	239	27,595	1891	319	32,687
1884	270	30,198	1892	756	65,374
1885	390	41,484	1893	907	78,460
1886	475	48,519	1894	441	41,230
1887	312	29,059	1895	918	91,300
1888	460	44,871	1896	1,360	114,198
1889	252	29,349			

Arrivals and clearances of vessels for fifteen years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1882	134	134	1890	268	268
1883	131	131	1891	160	159
1884	152	158	1892	146	145
1885	188	190	1893	183	183
1886	210	210	1894	219	221
1887	164	164	1895	186	181
1888	190	190	1896	202	200
1889	168	168			

G G 2.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

Agate Bay, on which is situated the town of Two Harbors, Minn., is a semicircular harbor of 2,000 feet radius. There is a good navigable depth throughout the greater part of the harbor, but it is exposed to storms from the southwest and from reverse swells of hard storms from the northeast.

The natural shelter it afforded justified the erection of three extensive ore docks by the Duluth and Iron Range Railroad, also a good commercial dock and a dock for landing coal.

The rapid increase in the commerce of the harbor caused Congress to undertake its improvement by an appropriation of $22,500 in August, 1886.

The approved project of 1887 was to construct two breakwater piers on a line toward each other from the eastern and western points of the bay, to be 1,000 and 900 feet long, respectively, leaving an opening of 1,340 feet between their extremities and inclosing an area of 109 acres.

The amount expended on this project up to the close of the fiscal year June 30, 1896, was $108,102,70. At that date the work done had greatly aided commerce by giving protection from storms to the commercial and ore docks. The work done during the fiscal year ending June 30, 1897, has augmented this protection.

The original estimate of cost was $213,000, which was increased to $244,208 in Annual Report of 1887 on account of higher prices.

The object is to protect shipping at the wharves, which otherwise would be greatly exposed. Work was commenced in 1887 on the east pier, which is now 750 feet in length, leaving 250 feet to be built to complete. In 1893, 200 feet of the west pier was built.

In 1895–96 300 linear feet of riprap embankment, in over 40 feet of water, to a height of 20 feet, was built, in continuation of the west breakwater. In 1896, under the contract with Samuel Meniece, mentioned in the last Annual Report, page 2337, nearly 250 linear feet of timber crib and superstructure was built on top of this embankment. In October, 1896, a large vessel went adrift during an unusually severe storm, and was dashed against the uncompleted end of the west breakwater, carrying away and completely destroying about 100 linear feet. It being too late in the season to replace this, the wrecked end was secured so as to carry through the winter, and is now being replaced by Meniece under his contract, which is still in force.

In November, 1896, a contract was made with Porter Bros., of Duluth, Minn., approved December 16, 1896, to build 410 linear feet of riprap embankment, in some 43 feet of water, to a height of 20 feet. Of this, about 81 linear feet has been finished. The whole work is to be completed November 1, 1897.

This spring about $1,150 was expended, under a contract with Samuel Meniece, of Duluth, Minn., dated February 23, 1897, approved March 5, 1897, in repairing the east breakwater, by replacing rotten decking, cross-ties, and upper wall timbers. This leaves this structure in very fair condition. The balance of the funds available will be expended under a contract which will be made this coming winter, in continuing the timber breakwater on the west side, work to begin on or before May 15, 1898, and be completed by November 1, 1898.

There is not yet perfect security from southwest storms for vessels lying at the merchandise dock, but it is no longer necessary to leave the harbor and seek security elsewhere. The favorable results already obtained with the portions of the breakwater now built are much greater than anticipated, and emphasize the advisability of speedily completing the remainders of the projected piers.

The Duluth and Iron Range Railroad has now in successful operation five large ore docks.

Of iron ore alone there was shipped from this port during the season of 1896, 1,814,186 gross tons.

The total amount expended on this harbor from 1886 to June 30, 1897, has been $120,999.70. During this period of eleven years the annual cargo tonnage has increased from 236,000 tons, valued at $524,800, in 1885, to 1,905,559 tons, valued at $2,650,000, in 1896. The total valuation of the cargo tonnage into and out of this port in the eleven years ending December 31, 1896, is roughly estimated at $20,528,000.

During the past year the operations in the harbor have been continued under the very efficient executive direction of Mr. John Krey, assistant engineer.

Agate Bay, known locally as Two Harbors, is in the collection district of Duluth, Minn., which is also the nearest port of entry. The nearest light-house is situated on the east point, Agate Bay, Minnesota.

Money statement.

July 1, 1896, balance unexpended		$64,397.30
June 30, 1897, amount expended during fiscal year		12,897.00
July 1, 1897, balance unexpended		51,500.30
July 1, 1897, outstanding liabilities	$4,442.77	
July 1, 1897, amount covered by uncompleted contracts	24,124.61	
		28,567.38
July 1, 1897, balance available		22,932.92
Amount (estimated) required for completion of existing project		71,708.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		71,708.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations for improving harbor at Agate Bay, Minnesota.

By act of Congress—

Approved August 5, 1886	$22,500
Passed August 11, 1888	15,000
Approved September 19, 1890	25,000
Approved July 13, 1892	30,000
Passed August 7, 1894	30,000
Passed June 3, 1896	50,000
Total	172,500

ESTIMATES.

Amount necessary to complete the present approved project as based on the last estimate of 1887	$71,708
Amount required annually for preserving and maintaining the improvement after completion	2,000

Abstract of proposals received at Duluth, Minn., for riprap embankment at Agate Bay (Two Harbors), Minnesota, opened October 20, 1896, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	410 feet of embankment, more or less, per running foot of embankment.
1	William H. Randall, West Duluth, Minn	$91.34
2	Jacob H. Carlson, Duluth, Minn	71.15
3	Samuel Meniece, Duluth, Minn	84.20
4	Tulloch Bros. & Magee, Duluth, Minn	85.90
5	A. & D. Sang, Duluth, Minn	89.25
6	Jacob Zimmerman, Duluth, Minn	75.48
7	George R. King & Hugh Steele, Duluth, Minn	71.90
8	Cooper & Doubleday, St. Paul, Minn	157.98
9	Elisha G. Gray, Oneida, N. Y	205.00
10	William McCurdy, Houghton, Mich., and Alex. McCurdy, Duluth, Minn	81.00
11	Powell & Mitchell, Marquette, Mich	76.48
12	Porter Bros., Duluth, Minn	68.17
13	Walter H. Singer, Duluth, Minn	85.00

Abstract of proposals received at Duluth, Minn., for repairs to breakwater at Agate Bay (Two Harbors), Minnesota, opened January 30, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For timber in place, including the iron and fastening, etc., 43,000 feet B. M., more or less (per 1,000 feet B. M.).	For new stone in place, about 70 cords, more or less (per cord).	Total.
1	John Somerville, Duluth, Minn	$21.00	$5.50	$1,288.00
2	Porter Bros., Duluth, Minn	39.00	4.75	2,009.50
3	A. & D. Sang, Duluth, Minn	28.00	6.80	1,680.00
4	Alex. McCurdy, Duluth, Minn., Wm. McCurdy, Houghton, Mich	28.50	5.00	1,575.50
5	John Shulene, Duluth, Minn	22.05	4.75	1,280.65
6	Samuel Meniece, Duluth, Minn	18.75	4.75	1,138.75
7	Tulloch Bros. & Magee, Duluth, Minn	43.50	10.00	2,570.50

LIST OF EXISTING CONTRACTS.

Contract for riprap embankment awarded to Porter Bros., Duluth, Minn., approved December 16, 1896. Commenced work December, 1896. To be completed November 1, 1897.

Contract for repairs to East breakwater awarded to Samuel Meniece, Duluth, Minn., approved March 5, 1897. Commenced May 1, 1897. To complete July 1, 1897.

Contract with Samuel Meniece, of Duluth, Minn., for building 250 feet extension to the west pier was commenced May 1, 1896, and was to be completed November 1, 1896. When the work was about ready for acceptance a storm wrecked a vessel against the breakwater and wrecked the work. The completion of this contract is now in progress, to be completed this season.

COMMERCIAL STATISTICS.

Vessels arriving and departing at Agate Bay, Minnesota.

Year.	Vessels.	Estimated tonnage.	Increase.
1885	174	295,800	....
1886	263	460,000	164,200
1887	465	697,500	237,500
1888	749	1,436,000	738,500
1889	1,255	2,400,000	964,000
1890: Steam, 968 Sail, 82	1,050	2,625,000	225,000
1891: Steam, 1,188 Sail and whaleback, 62	1,250	2,915,000	290,000
1892: Steam, 1,104 Sail, 186 Whaleback, 40	1,330	3,101,600	186,600
1893: Steam, 1,016 Sail, 146 Whaleback, 16	1,178	2,386,200	—715,400
1894: Steam, 1,432 Sail, 116 Whaleback, 70	1,618	3,236,000	849,800
1895: Steam, 1,748 Sail, 350 Whaleback, 396	2,494	4,900,000	1,664,000
1896: Steam, 1,444 Sail, 310 Whaleback, 228	1,982	4,360,000	—540,000

Value of freight received and shipped, exclusive of iron ore, $378,000.

Receipts and shipments.

Year.	Ore shipped.	Other freight received and shipped.	Total.
	Tons.	*Tons.*	*Tons.*
1885	225,484	10,895	236,379
1886	304,396	21,954	326,350
1887	394,252	6,620	400,872
1888	509,964	30,352	540,316
1889	924,054	31,781	955,785
1890	984,215	37,268	1,021,483
1891	1,000,052	41,181	1,041,233
1892	1,304,885	54,477	1,359,362
1893	902,268	57,616	959,884
1894	1,373,117	66,053	1,439,170
1895	2,139,526	79,004	2,218,530
1896	1,814,186	91,373	1,905,559

Estimated value of freight received and shipped (exclusive of ore).

Year.	Amount.	Year.	Amount.
1887	$96,000	1892	$320,000
1888	212,000	1893	360,000
1889	222,000	1894	300,000
1890	246,000	1895	220,000
1891	225,000	1896	378,000

There were no new lines of transportation established last year, but several new boats were added to the old lines.

G G 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA, AND SUPERIOR, WISCONSIN.

This harbor has heretofore been reported on under the separate titles of Duluth, Minn., and Superior, Wis. For history, etc., see last Annual Report, pages 2339–2352. The act of June 3, 1896, unified these harbors under above title and provided for continuous contracts for its improvement to the amount of $3,080,553.

This harbor consists now of the Duluth Canal, the Wisconsin Entrance, Superior Bay, Allouez Bay, St. Louis Bay, and St. Louis River to the limits of the cities of Duluth and Superior, about 20 miles from the original natural entry, which, before improvement, was obstructed by shifting bars, with but 9 feet of water over them. The bays were broad expanses of shallow water, averaging only 8 or 9 feet, except along the channel through them, where the depth was greater, but variable.

The previous projects have been practically completed, and have resulted in giving a good 16-foot navigation through the natural or Wisconsin Entry, through the artificial Duluth Canal, over the Duluth Basin of 104 acres, along and parallel to the dock lines of Duluth and Superior, in Superior and St. Louis bays, and up the St. Louis River to New Duluth, near the head of navigation of the river, with defined channels from 85 to 300 feet in width.

The amount expended thereon up to the close of the fiscal year ending June 30, 1896, was $1,539,183.75. The improvement thus made is in excellent condition, and the expenditure has been amply justified by the immense commerce which it has readily accommodated. (See commercial statistics hereafter.)

The expenditure during the fiscal year ending June 30, 1897, amounting to $48,319.22, has resulted in widening existing channels, in repairs to the piers, and in removing a few shoals due to temporary and abnormal causes.

The new project authorized by the act of June 3, 1896, provides for the widening and deepening to 20 feet of existing channels, for a new 20-foot channel along Minnesota Point dock line, for new channels in Allouez Bay, for extensive turning and anchorage basins 20 feet deep at the junctions of two or more channels, for widening the Duluth Canal, and for replacing with substantial structures of timber and monolithic concrete the piers at the Duluth Canal and the Wisconsin Entrance.

As the result of extensive advertising, continuous contracts for the dredging of about 26,000,000 cubic yards of material, at an average cost of a trifle less than 8 cents a cubic yard, have been made with Williams, Green & Williams, of Duluth, Minn., and Chas. S. Barker, of Superior, Wis., thus strongly demonstrating the economic value of this method of contracting, the original estimate, based upon preceding experience and including administration expenses, having been 15 cents a cubic yard.

The sundry civil act of June 4, 1897, appropriated $437,500, all of which will be expended under existing contracts for dredging and in purchasing land for the Duluth Canal; for the land under and adjacent to the southerly pier of the Wisconsin Entrance, and in executing contracts to be made this fall and winter for the Duluth Canal piers.

The act of June 3, 1896, provides that not more than 25 per cent of the total contract allowance of $3,080,553 shall be expended in any one fiscal year, beginning July 1, 1897, unless the excess over 25 per cent was earned in the preceding fiscal year but subsequent to July 1, 1897. Fifty per cent of $3,080,553 is $1,540,276; deduct $437,500 already appropriated, and we have $1,102,776 as the amount which should be available on or before the end of the second fiscal year, June 30, 1899.

The city of Duluth has finally deeded to the United States all its remaining landed interests in and adjacent to the Duluth Canal, and condemnation proceedings for the balance of the land needed have been begun.

The lake commerce of this port, Duluth and Superior, during the last season of navigation amounted to over $112,000,000, as a very conservative valuation, and since the United States took charge of this harbor this commerce has amounted to over $900,000,000.

The work under the two dredging contracts was begun in June as soon as the appropriation was made, and there are now eight dredges at work, and one or two more will be put on very soon. It is expected that the full force of at least fifteen dredges will be ready to resume operations in the spring of 1898. The whole contract is to be completed by November 1, 1901–1902, depending upon the amount to be dredged, the United States having an option to lessen the total amount by 3,000,000 cubic yards.

The last map of the harbor was published in Appendix J J, Report of the Chief of Engineers, 1893.

The system of vessel reports of cargo and passengers entering and leaving the harbor was enforced in 1896, and the results are shown in the commercial statistics, which are so accurate that the local collector of customs is using the data for reference in some of the business of his office.

Plans for the widening of the Duluth Canal and the construction of strong, massive, and handsome piers are now in course of preparation. It is proposed to dredge a trench some 24 or 25 feet below low-water datum; in this to drive piles, butts down, and saw them off at the reference of −22 feet. On these piles, thus leveled off, to place very heavy, tight timber cribs, filled with gravel, and having double walls toward the canal side; the top of cribs to be 1 foot below low-water datum, and on these cribs to build in situ massive monolithic concrete superstructures, with parapets and high pierheads, the piers extending out to 20 feet depth of water.

As soon as the drawings and specifications are ready the work will be extensively advertised, and a contract for the substructure will be entered into this fall, work to begin in the spring of 1898. The concrete superstructure will probably be built by day labor and the purchase of material by contract, after due advertisement.

In the preparation of the plans for the large works now either under way or soon to be started, I have had the able, intelligent, and zealous assistance of Mr. J. H. Darling and Mr. F. L. Dever, assistant engineers, and the office force, under the direction of Mr. James L. Owen, chief clerk, has effectively handled the clerical and accounting work.

The laws of the United States as applicable to its navigable waters have been rigidly enforced through the intelligent and energetic efforts of Mr. H. C. Bellinger, the harbor inspector, and all well-established cases of violations of the law have been promptly reported to the proper United States district attorneys.

This work is in the collection districts of Duluth, Minn., and Superior, Wis., Marquette, Mich., being the port of entry for the latter. The nearest light-houses are at the two entrances.

Money statement.

July 1, 1896, balance unexpended		*$58, 975. 25
Amount appropriated by sundry civil act approved June 4, 1897		437, 500. 00
		496, 475. 25
June 30, 1897, amount expended during fiscal year		48, 319. 22
July 1, 1897, balance unexpended		448, 156. 03
July 1, 1897, outstanding liabilities	$9, 000. 00	
July 1, 1897, amount covered by uncompleted contracts	1, 991, 500. 00	
		2, 000, 500. 00
Amount (estimated) required for completion of existing project		2, 643, 053. 00
Amount that can be profitably expended in fiscal year ending June 30, 1899		1, 102, 776. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Abstract of appropriations for impvoving harbor at Duluth, Minn., and Superior, Wis.

By act of Congress of June 3, 1896	$50, 000
By sundry civil act of June 4, 1897	437, 500
Total	487, 500

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*Twenty-four dollars withdrawn from Treasury, account transfer settlement, by Third Auditor, Treasury Department, July 5, 1890, of Capt. J. B. Quinn's accounts. (Letter from office Chief of Engineers, U. S. A., April 3, 1897, E. F. M. $\frac{6196}{41}$.)

Abstract of appropriations for improving harbor at Duluth, Minn.

By act of Congress approved—	
March 3, 1871	$60,000.00
June 10, 1872	50,000.00
Allotted from act passed March 3, 1873	36,049.20
By act of Congress approved—	
June 23, 1874	10,000.00
March 3, 1875	35,000.00
August 14, 1876	15,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	25,000.00
March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved—	
July 5, 1884	45,000.00
August 5, 1886	56,250.00
By act of Congress passed August 11, 1888	80,000.00
By act of Congress approved—	
September 19, 1890	100,000.00
July 13, 1892	125,000.00
By act of Congress passed August 7, 1894	75,000.00
Total	852,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies.

Total amount expended to June 30, 1896:	
Breakwater	$110,000.00
Canal piers, etc	97,660.65
Dredging	637,237.98
Total	*844,898.63
Expended prior to present project:	
Breakwater	110,000.00
Canal piers, etc	45,698.33
Dredging	114,953.48
Total	270,651.81
Expended under the present project (adopted in 1881):	
Canal piers, etc	51,962.32
Dredging	522,284.50
Total	574,246.82

Abstract of appropriations for improving harbor at Superior Bay and St. Louis Bay, Wisconsin.

By act of Congress approved—	
March 3, 1867	$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	63,950.80
Allotted from appropriation for "Repairs of harbors on Northern lakes"	5,433.00
By act of Congress approved—	
August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00

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* Balance of $7,400.57 taken up under Duluth-Superior appropriation.

By act of Congress approved—Continued.	
August 2, 1882	$40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00
By act of Congress—	
Passed August 11, 1888	50,000.00
Approved September 19, 1890	65,000.00
Approved July 13, 1892	70,000.00
Passed August 7, 1894	50,000.00
Total	695,883.80

EXPENDITURES.

Amount expended under original project, adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1896	358,771.86
Total	694,285.12

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Repairs and beach protection	$13,233.00
Construction and repair to piers	332,679.96
Dredging	348,372.16
Total	*694,285.12

Abstract of proposals received for dredging in the harbor of Duluth, Minn., and Superior, Wis., and opened June 20, 1896, at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For dredging channels in St. Louis Bay, per cubic yard.	For dredging channels in Superior Bay, per cubic yard.	For removing dike, per linear foot.	For dredging St. Louis River above Grassy Point.	
					Dumping in Lake Superior.	Dumping to be above Grassy Point.
		Cents.	*Cents.*		*Cents.*	*Cents.*
1	West Duluth Land Co., O. H. Simonds, secretary, Duluth, Minn.			$0.40	19	14
2	Williams, Green & Williams, Duluth, Minn	12	13½	1.45	18	12
3	Charles S. Barker, West Superior, Wis	14½	11⅜	1.65	21	15½

Contract awarded to West Duluth Land Company for dredging out the dike. Approved August 27, 1896. Work was commenced in September and completed October 9, 1896.

Contract awarded to Williams, Green & Williams for dredging in St. Louis Bay. Approved October 2, 1896. Work commenced August 1 and completed October 6, 1896.

Contract awarded to Charles S. Barker for dredging Superior Bay. Approved August 28, 1896. Work commenced August 1, 1896, and completed October 12, 1896.

About $30,000 expended on all three contracts.

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* Balance of $1,598.68 taken up under Duluth-Superior appropriation.

Abstract of bids opened at Duluth, Minn., February 1, 1897, by Maj. Clinton B. Sears, Corps of Engineers, for repairs to canal piers, Duluth, Minn.

No.	Name and address of bidder.	New timber in place below datum, 3,000 feet B. M. more or less, with fastenings, per 1,000 feet.	New timber in place above datum, 9,000 feet more or less, with fastenings, per 1,000 feet.	Taking off old timber, 1,200 feet B. M. more or less, per 1,000 feet.	Relaying old timber, with fastenings, 900 feet more or less, per 1,000 feet.	Furnishing and placing 25 piles, more or less, as per paragraph 5 of bid, per pile.	Furnishing and placing 50 piles, more or less, as per paragraph 6 of bid, per pile.	Total.
1	Whitney Bros., West Superior, Wis.	$26.10	$19.00	$8.00	$8.00	$4.00	$5.00	$616.10
2	Samuel Meniece, Duluth, Minn.	20.00	16.00	1.50	3.00	3.75	5.00	552.25
3	J. W. Preston, Duluth, Minn.	40.00	30.00	20.00	10.00	4.50	6.50	860.50
4	John Somerville, Duluth, Minn.	35.00	22.00	5.00	6.00	6.00	7.20	824.40
5	Tulloch Bros. & Magee, Duluth, Minn.	97.00	19.50	4.00	7.00	4.75	5.00	846.35
6	Lewis G. Moran, West Superior, Wis.	25.00	20.00	6.00	6.00	6.00	6.00	717.60
7	F. P. Tims, West Duluth, Minn	35.00	20.00	6.00	10.00	7.00	7.50	851.20
8	J. B. Wanless & Co., Duluth, Minn.	21.00	19.00	5.00	5.00	4.00	4.25	557.00
9	David Hood, Duluth, Minn.	90.00	24.00	12.00	12.00	4.00	5.00	861.20
10	John Shulene, Duluth, Minn.	41.79	24.79	10.00	12.79	4.10	4.50	699.49

Letter bid and acceptance. No formal contract. Work done by Samuel Meniece during February and March, 1897.

Abstracts of proposals received at Duluth, Minn., for dredging in the harbor at Duluth, Minn., and Superior, Wis., opened February 15, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For dredging.			
		In District No. 1, 13,563,000 cu. yds., per cu. yd., scow measurement.	In District No. 2, 5,264,000 cu. yds., per cu. yd., scow measurement.	In District No. 3, 2,173,000 cu. yds., per cu. yd., scow measurement.	Total.
		Cents.	*Cents.*	*Cents.*	
1	Eugene Breymann, John B. Breymann, Toledo, Ohio	10¼	11¼	13½	$2,275,762.50
2	P. McDonnell, Duluth, Minn	7½	8	10	1,655,645.00
3	Chas. S. Barker, West Superior, Wis	7½	8	10	1,655,645.00
4	American Dredging Co. et al, Philadelphia, etc.	9	10	11	1,986,100.00
5	C. E. Mitchell & Co., Ludington, Mich	11	13	15	2,502,200.00
6	Williams, Green & Williams, Duluth, Minn	7½	8	10	1,655,645.00
7	Samuel O. Dixon, Racine, Wis	12½	15	18	2,867,115.00
8	The Lyden & Drews Co., Chicago, Ill	12 7/10	13 7/10	14 3/10	2,754,408.00
9	Alphonse B. Bowers, San Francisco, Cal	12½	12½	12½	2,625,000.00
10	Wm. A. Starke, Milwaukee, Wis	10	11	13	2,217,830.00
11	The L. P. & J. A. Smith Co., Cleveland, Ohio	12	12	15	2,585,190.00
12	James Rooney, Toledo, Ohio	10	11⅛	13¼	2,229,842.50
13	R. J. Cram, Detroit, Mich	12¼	13⅛	15⅛	2,681,033.75

Work divided between Williams, Green & Williams, Duluth, Minn., and Charles S. Barker, West Superior, Wis.

Bids for Superior Entry dredging, opened April 10, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	Per cubic yard.
		Cents.
1	Williams, Green & Williams, Duluth, Minn.	10
2	West Duluth Land Co., Duluth, Minn.	11¾
3	Chas. S. Barker, West Superior, Wis.	11¾

Bid of Williams, Green & Williams accepted. No formal contract. Work done during April and May, 1897, amounting to about $1,000.

LIST OF EXISTING CONTRACTS.

Contracts for dredging some 26,000,000 cubic yards of material, more or less, with Williams, Green & Williams, of Duluth, Minn., for one-half; contract dated March 18, 1897, approved April 29, 1897; work commenced June, 1897, and to be completed by November 1, 1901-1902, contingent upon appropriations being made. Charles S. Barker, of West Superior, for one-half; contract dated March 18, 1897, approved May 8, 1897; work begun in June, 1897, and to be completed November 1, 1901-1902, contingent upon appropriations being made.

COMMERCIAL STATISTICS, DULUTH, MINN.

Comparative statement of arrivals and clearances, 1895 and 1896.

Year.	Arrivals.	Clearances.	Total.	Tonnage.	Average tonnage.
1895	3,786	3,782	*a* 7,568	7,391,280	*b* 1,172
1896	3,737	3,686	*a* 7,423	8,668,811	*b* 1,257
Increase	—49	—96	—145	1,277,531	85

a Steam, 6,005; sail, 1,418.

b Exclusive of tugs with freight.

Principal domestic commodities received and shipped by lake, 1896.

Receipts.	Tons.	Shipments.	Tons.
Coal	662,123	Wheat	867,753
Cement and lime	27,005	Flour	372,944
Building stone	9,458	Other grains	343,198
Salt	16,327	Structural iron or steel	180
Machinery	435	Iron ore	1,981,597
Manufactured iron	40,386	Copper	5,798
Fish, kerosene oil, etc	1,072	Miscellaneous merchandise	17,215
General merchandise	116,002	Lumber	418,912
Sand	10,426	Wool	935
Total	*a* 883,234	Total	4,008,532

	Net tons.	Valuation.
Total receipts	883,234	*b* $16,160,704
Total shipments	4,008,532	43,416,794
Receipts and shipments	4,891,766	59,577,498

a These figures do not include some 76,000,000 feet of logs in rafts.

b Valuations are based on average wholesale prices on board vessels for exports and landed on docks for imports.

Passengers, arriving	23,176
Passengers departing	22,498
Total	45,674

Receipts of coal and shipments of flour eastward for fourteen years.

Year.	Coal.	Flour.	Year.	Coal.	Flour.
	Tons.	*Tons.*		*Tons.*	*Tons.*
1883	420,000	91,896	1890 *a*	735,995	149,112
1884	372,000	79,801	1891	778,982	170,774
1885	695,000	113,190	1892	1,168,068	288,483
1886	736,000	133,036	1893	1,124,771	301,988
1887	1,041,000	129,627	1894	932,679	546,580
1888	1,435,000	171,228	1895	581,682	407,003
1889	1,045,000	198,053	1896	662,123	372,944

a Coal receipts prior to 1890 are given for the head of the lake (Duluth and Superior); since then for Duluth only.

The storage capacity of Duluth elevator system is 24,650,000 bushels, and that of Duluth elevators proper 11,350,000 bushels. The following table gives the receipts and shipments of wheat for twenty-six years:

Year ending—	Receipts.	Shipments.	Total.	Year ending—	Receipts.	Shipments.	Total.
December 31—	*Tons.*	*Tons.*	*Tons.*	August 31—	*Tons.*	*Tons.*	*Tons.*
1896	1,748,780	1,296,862	3,045,642	1883	141,234	137,607	278,841
1895	1,487,981	1,092,516	2,580,497	1882	97,987	99,264	197,251
1894	750,000	763,110	1,513,000	1881	99,965	85,966	185,931
1893	987,312	1,011,025	1,998,337	1880	40,430	43,610	84,040
1892	1,399,817	932,222	2,332,039	1879	54,722	44,617	90,339
1891	1,144,082	1,058,449	2,202,531	1878	54,092	54,000	108,092
1890	460,244	427,725	887,969	1877	13,817	15,117	28,934
1889	513,827	409,410	923,237	1876	43,536	41,292	84,828
1888	239,802	404,485	644,287	1875	34,137	32,436	66,573
1887	514,089	585,558	1,059,647	1874	67,224	72,725	139,949
1886	675,977	530,048	1,206,025	1873	59,444	47,495	106,939
1885	446,590	421,973	868,563	1872	27,948	28,531	56,479
1884	411,688	345,537	758,235	1871	16,703	16,345	33,048

The above figures show the movement of wheat at the head of the lake (Duluth and Superior combined).

Average vessel tonnage for twelve years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1885	761	1889	970	1893	1,160
1886	778	1890	1,081	1894	1,217
1887	812	1891	1,129	1895	1,172
1888	887	1892	1,095	1896	1,257

Comparative statement of arrivals and clearances of vessels at Duluth for twenty years.

Year.	Arrivals.	Clearances.	Total.	Year.	Arrivals.	Clearances.	Total.
1877	329	228	557	1887	1,237	1,238	2,475
1878	406	343	749	1888	1,100	1,100	2,200
1879	502	497	999	1889	1,263	1,265	2,528
1880	524	524	1,048	1890	1,266	1,268	2,534
1881	666	660	1,326	1891	1,444	1,451	2,895
1882	833	832	1,665	1892	1,735	1,747	3,482
1883	796	779	1,475	1893	1,642	1,663	3,305
1884	888	903	1,791	1894	2,234	2,280	4,514
1885	808	989	1,797	1895	3,786	3,782	7,568
1886	1,026	995	2,021	1896	3,737	3,686	7,423

Comparative statement of imports and exports.

Year.	Imports.	Duties.	Tonnage duty.	Total duties.	Value of domestic exports.	Value of foreign exports.
1888	$86,901	$2,909.00	$23.40	$2,932.40	$1,207,858	....
1889	21,852	2,931.00	49.80	2,980.80	1,405,447	....
1890	48,027	5,255.86	13.20	5,269.06	1,521,751	....
1891	155,446	4,764.97	86.40	4,851.37	2,079,178	....
1892	117,759	16,706.28	127.84	16,834.12	1,837,936	....
1893	180,797	14,496.34	154.89	14,651.23	1,419,699	....
1894	111,840	10,163.90	82.62	10,246.52	1,696,950	$815,356
1895	1,350,264	254,435.92	114.06	254,549.98	2,200,164	1,224,086
1896	1,154,123	220,638.81	95.46	220,734.27	2,857,742	1,075,379

Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27	Nov. 29	1892	Apr. 16	Dec. 30
1886	May 7	Dec. 14	1893	May 9	Dec. 1
1887	May 4	Dec. 28	1894	Apr. 19	Dec. 15
1888	May 11	Dec. 31	1895	Apr. 15	Dec. 16
1889	Apr. 11	Dec. 4	1896	Apr. 12	Dec. 17
1890	Apr. 16	Dec. 8	1897	Apr. 15	
1891	Apr. 30	Dec. 6			

Detailed statement of arrivals, clearances, and registered tonnage of vessels through the Duluth Canal for the season of 1896.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
April	124	106	230	265,649
May	578	569	1,147	1,266,667
June	608	605	1,213	1,327,342
July	689	677	1,366	1,396,472
August	563	548	1,111	1,224,896
September	474	485	959	1,249,723
October	363	356	719	994,655
November	304	308	612	834,664
December	34	32	66	108,743
Total	3,737	3,686	7,423	8,668,811

Total tons cargo received through Duluth Canal	2,022,000
Total tons cargo departing through Duluth Canal	4,959,980
Total tons cargo entering and departing through Duluth Canal	6,981,980

Vessel report for Duluth Canal, season of 1896.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which came through Duluth Canal and discharged—			
At Duluth	816	800,832	792,813
At Superior	561	843,926	1,026,407
At Duluth (90,421 tons); at Superior (112,359 tons)	272	368,988	202,780
Number which came through Duluth Canal light or with passengers	2,088	2,282,238	....

DEPARTING.

Number which departed through Duluth Canal with cargo from Duluth	2,129	2,676,729	3,596,733
Number which departed through Duluth Canal with cargo from Superior	221	389,923	605,400
Number which departed through Duluth Canal with cargo from Duluth (411,799 tons) and Superior (346,048 tons)	442	600,771	757,847
Number which departed through Duluth Canal light or with passengers	894	705,404	....

NEW LINES OF TRANSPORTATION.

Great Lakes Steamship Company, 4 steamers.

Bessemer Steamship Company of Duluth, Minn., with 9 steamers and 9 tow barges.

Zenith and Empire Transit Company of Duluth, Minn., with 4 steamers.

Lake Superior Transportation Line of Duluth, Minn., with 3 steamers.

All the above are deep-draft vessels. Besides a number of wild vessels, belonging to no particular line.

Commerce for the head of the lakes (Duluth, Minn., and Superior, Wis., combined) for the navigation season of 1896.

Receipts.	Tons.	Shipments.	Tons.
Anthracite coal	694, 243	Iron ore	2, 146, 630
Bituminous coal	1, 371, 709	Copper	54, 946
Building stone	10, 808	Flour	802, 053
Salt	33, 236	Wheat	1, 471, 103
Machinery	559	Other grains	485, 444
Manufactured iron	62, 255	Structural iron or steel	325
General merchandise	169, 296	Wool	3, 493
Lime and cement	82, 004	Merchandise	27, 583
Kerosene oil	16, 152	Lumber	485, 376
Fish	746		
Sand	16, 872	Total	5, 478, 953
Total	2, 407, 880		

Total tons cargo entered and departed	7, 886, 833
Valuation	$111, 676, 900
Total arrivals and departures	10, 948
Registered tonnage	13, 853, 068

Arrivals and clearances of vessels at Superior, Wis., for two years.

Year.		Arrivals and clearances.	Average vessel tonnage.	Tonnage.
1896:				
Steam	3, 082	3, 525	[a] 1, 446	4, 684, 257
Sail	443			
1895:				
Steam	2, 734	3, 418	1, 183	4, 042, 992
Sail	684			
Increase		107	263	641, 265

[a] Exclusive of tugs.

The storage capacity of the Superior elevators is 13,500,000 bushels.

Vessel report for Superior Harbor for season of 1896.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which entered Superior Harbor via Duluth Canal	833	1, 212, 914	1, 138, 766
Number which entered Superior Harbor light via Duluth Canal	360	481, 010	....
Number which came in Wisconsin Entry and discharged at Superior	223	329, 640	[a] 385, 880
Number which entered Wisconsin Entry light, or with rafts in tow	374	306, 553	....
Total	1, 790	2, 330, 117	1, 524, 646

DEPARTING.

Number which took cargo from Superior and departed through Duluth Canal	663	990, 694	951, 448
Number which left Superior light and departed through Duluth Canal	181	258, 106	....
Number which loaded at Superior and departed through Wisconsin Entry	346	464, 866	518, 973
Number which left Superior light and took cargo on at Duluth and departed via Duluth Canal	367	525, 556	....
Number which departed through Wisconsin Entry light or with booms in tow	[b] 178	115, 418	....
Total	1, 735	2, 354, 140	1, 470, 421

[a] These figures do not include 20,680,000 feet of logs towed in through the entry by tugs.
[b] These figures do not include tugs which passed in and out of the entry with dump scows.

Vessel report for Wisconsin Entry for season of 1896.

ENTERING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which came through Wisconsin Entry and discharged at Superior	223	329, 640	[a] 385, 880
Number which came through Wisconsin Entry light or with rafts in tow	374	306, 553	....

DEPARTING.

	Boats.	Registered tonnage.	Tons of cargo.
Number which took cargo from Superior and departed through Wisconsin Entry	346	464, 366	518, 973
Number which departed through Wisconsin Entry light or with booms in tow	178	115, 418	....

[a] These figures do not include 20,680,00 feet of logs towed in through the entry by tugs.

Shipments and receipts by lake of leading articles during season of 1896.

Shipments.	Tons.	Receipts.	Tons.
Wheat	603, 350	Coal	1, 403, 829
Other grain	142, 246	Cement and lime	4, 999
Flour	429, 109	Kerosene oil	15, 817
Wool	4, 558	Salt	16, 909
Structural iron	145	Miscellaneous	83, 092
Copper ore	49, 148		
Lumber	66, 464	Total	1, 524, 646
Iron ore	165, 033		
Merchandise	10, 368	Total receipts and shipments	2, 995, 067
		Total value	$52, 099, 402
Total	1, 470, 421		

Passengers departing	2, 042
Passengers arriving	1, 974

Valuations are based on average wholesale prices on board vessels for exports and landed on docks for imports.

Comparative statement of receipts and shipments for thirteen years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1884	17, 462	1889	1, 006, 542	1893	1, 913, 350
1885	33, 626	1890	1, 495, 385	1894	2, 598, 264
1886	117, 027	1891	1, 616, 648	1895	2, 577, 281
1887	170, 020	1892	1, 733, 444	1896	2, 995, 067
1888	327, 327				

Detailed statement of arrivals and clearances of vessels at Superior, Wis., for season of 1896.

Month.	Arrived.	Cleared.	Total.	Registered tonnage.
April	53	60	113	150, 276
May	258	260	518	635, 409
June	284	269	553	682, 174
July	312	298	610	728, 236
August	271	254	525	695, 445
September	228	217	445	633, 409
October	172	174	346	485, 185
November	188	192	380	606, 162
December	24	11	35	67, 961
Total	1, 790	1, 735	3, 525	4, 684, 257

Average tonnage per vessel, exclusive of tugs, 1,446.

Of the number of vessels reported above for 1896 there were 3,082 steam and 443 sailing vessels. The steamers were divided as follows: 2,552 freight propellers, 239 passenger and freight combined, and 291 tugs.

Comparative statement of arrivals and clearances of vessels for thirteen years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1884	194	119,288	1891	1,610	2,984,468
1885	200	113,519	1892	1,940	2,498,507
1886	316	283,787	1893	1,909	2,571,917
1887	462	404,780	1894	2,000	2,829,968
1888	812	915,816	1895	3,418	4,042,992
1889	900	1,122,048	1896	3,525	4,684,257
1890	1,256	1,541,777			

NEW LINES OF TRANSPORTATION.

Great Lakes Steamship Company, four steamers.

Bessemer Steamship Company, of Duluth, Minn., nine steamers and nine tow barges.

Zenith and Empire Transit Company, of Duluth, Minn., with four steamers.

Lake Superior Transportation Line of Duluth, with three steamers.

All of the above are deep-draft vessels, besides a number of wild vessels belonging to no particular line.

G G 4.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

The southern end of Chequamegon Bay forms the harbor of Ashland, and as the length of the bay is considerable it was necessary to protect the wharves from the waves to enable vessels to use them at all times.

The approved project is for the construction of a pile, slab, and rock breakwater 8,000 feet long, and for dredging a channel of the necessary depth along the dock line. The present length of the breakwater is 7,363 feet. This length gives a protected area of some 1,600 acres and affords a safe anchorge and dockage for 3 miles along the city front.

The amount expended on this harbor up to the close of the fiscal year ending June 30, 1896, is $211,539.71, of which $127,000 has been for the construction of the breakwater, $53,539.71 for repairs to same, and $31,000 for closing the breach in Chequamegon Point and repairing same.

At that time the breakwater had fully accomplished the object of its construction, and will continue to do so as long as it is kept in repair. It consists of three rows of piling filled in between with slabs which are anchored with large rock.

This construction has only its original cheapness to commend it. It is proving very expensive to maintain. All of the preceding and nearly half of the last appropriation has been and is being expended in strengthening the older portion of the work.

During the year 2,000 cords of stone have been placed in the deficient pockets under contract with A. & D. Sang, of Duluth, dated September 12, 1896, and approved September 19, 1896, which contract is completed.

A contract for dredging to the amount of some $15,000 has been made with Charles S. Barker, of West Superior, Wis., dated April 24, 1897, approved June 1, 1897, at 11 cents a cubic yard, which is much cheaper than ever before. This contract is now in force and is to be completed October 15, 1897. The banking against the breakwater of the dredgings from the Wisconsin ore docks made last summer has stood well and greatly aided the old piling in resisting overthrow by storms and ice, and the dredgings under the present contract are also placed against the work on both sides. After the dredging has been completed the dredge will be placed alongside the breakwater and the outer toe of the embankment will be dug up and cast against the walls of the work, the crest of the embankment as formed by dumping the scows being some 15 feet from the sides of the breakwater. After the embankment thus cast up has had time to settle thoroughly and become consolidated the crest will be protected by a riprap of stone under future appropriations.

To complete the breakwater as originally projected will cost $20,000. Much stronger work should be put in, however, and it will be economy to spend on the remaining 637 feet $30,000 instead of $20,000.

At the request of the city council, a harbor line was established by the Secretary of War, March 13, 1896. There is no uniformity of depth along this line, however, and to give a channel 200 feet wide, with a navigable depth of 16 feet, will require the excavation of 425,000 cubic yards of material at a cost of $93,500, providing no bed rock or hardpan is encountered.

At an early day the breakwater should be extended in toward shore to protect the commercial interests which are increasing in the easterly part of the town, and I have been urged by prominent citizens to use the last appropriation for this purpose. The necessity, however, for holding on to the old work and protecting it was so urgent that I am expending the money as herein set forth, the dredging being done more to get material for embankment than to meet any immediate needs of navigation in the part of the harbor where the dredging is being done.

The principal shipments from Ashland are iron ore and lumber. Congress has appropriated between 1886 and 1896, both inclusive, $239,500 for the improvement of this harbor.

The commerce of this port during this period has increased from 892 arrivals and clearances, with cargo tonnage of 1,400,000 tons, in 1887, to 5,164 arrivals and clearances, with cargo tonnage of 2,400,000 tons, in 1896. During this period the commerce of this port is roughly estimated at a valuation of $300,000,000.

The work during last season and this has been under the exclusive charge of Mr. E. H. Foster, inspector. He has discharged his duties well, and to my entire satisfaction.

This work is in the collection district of Superior, Mich., Marquette, Mich., being the port of entry; nearest light-house, La Pointe, on Chequamegon Point, at entrance of Chequamegon Bay.

Money statement.

July 1, 1896, balance unexpended		$27,960.29
June 30, 1897, amount expended during fiscal year		9,308.27
July 1, 1897, balance unexpended		18,652.02
July 1, 1897, outstanding liabilities	$7,213.06	
July 1, 1897, amount covered by uncompleted contracts	9,500.00	
		16,713.06
July 1, 1897, balance available		1,938.96
Amount (estimated) required for completion of existing project		346,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

RECOMMENDATIONS.

For 637 feet extension to the breakwater	$30,000
For repairs and contingencies	240,000
For dredging	76,500
Total	346,500

Abstract of letter bids received at Duluth, Minn., August 31, 1896, by Maj. Clinton B. Sears, Corps of Engineers, U. S. A., for furnishing and placing 1,500 to 2,000 cords of stone in the breakwater at Ashland, Wis.

No.	Name and address of bidder.	Per cord in place.
1	A. & D. Sang, Duluth, Minn	$4.37
2	McCurdy Bros., Duluth, Minn	5.75
3	W. H. Singer, Duluth, Minn	5.75
4	Ashland Brownstone Co., Ashland, Wis	5.75
5	James Porter & Son, Duluth, Minn	4.48

Contract with A. & D. Sang, dated September 12, 1896, approved September 19, 1896. Work commenced October, 1896; completed June 30, 1897.

Abstract of proposals received at Duluth, Minn., for dredging in harbor at Ashland, Wis., opened April 15, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	Dredging 60,000 cubic yards (more or less), per cubic yard, scow measurement.	Use of plant per hour.
1	Williams, Green & Williams, Duluth, Minn	0.19\frac{1}{8}$	$11.00
2	Duluth Dredge and Dock Co., Duluth, Minn	.15$\frac{7}{8}$	9.75
3	Chas. S. Barker, West Superior, Wis	.11	10.50
4	West Duluth Land Co., Duluth, Minn	.16$\frac{9}{10}$	10.00

Abstract of existing contract.

Contract with Charles S. Barker, dated April 24, 1897, approved June 1, 1897. Work commenced May 1, 1897, now in progress. To be completed October 15, 1897.

Abstract of appropriations for improving harbor at Ashland, Wis.

By act of Congress—	
Approved August 5, 1886	$22,500
Of August 11, 1888	60,000
Approved September 19, 1890	60,000
Approved July 13, 1892	45,000
By act of Congress—	
Passed August 7, 1894	$25,000
Passed June 3, 1896	27,000
Total	239,500

COMMERCIAL STATISTICS.

[Very unreliable and unsatisfactory.]

Arrivals and clearances of vessels (Chequamegon Bay, including Washburn and Bayfield, Wis.) for four years.

Year.	Number.	Average tonnage.
1893	6,052	1,178
1894	6,142	....
1895	5,227	....
1896	5,164	....

Principal articles of export and import for 1896.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Iron ore	1,566,337	Coal	200,000
Pig iron	50,000	Oil	30,000
Stone, building	120,000	Salt, lime, and cement	25,000
Lumber	300,000	Merchandise and miscellaneous	100,000
Total	2,036,337	Total	355,000
		Total receipts and shipments	2,391,337

Comparative statement of receipts and shipments for ten years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,401,454	1891	3,217,541	1895	3,747,251
1888	1,357,472	1892 *a*	4,267,097	1896	2,391,337
1889	1,971,213	1893	2,759,870		
1890	2,816,924	1894	2,982,502		

Arrivals and clearances of vessels for ten years.

Year.	Number.	Year.	Number.	Year.	Number.
1887	892	1891	4,099	1895	5,227
1888	2,375	1892 *a*	7,104	1896	5,164
1889	3,171	1893	6,052		
1890	4,489	1894	6,142		

a Since 1892 report includes the ports of Washburn and Bayfield, on Chequamegon Bay.

G G 5.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

This harbor is formed by the mouth of the Ontonagon River, which flows out between two piers, 2,315 and 2,675 feet in length, respectively. The project is for maintaining a navigable depth of 12 feet between these piers, and up to the bridge just inside the entrance. This is done by dredging annually or biennially, as may prove necessary, at an annual cost of from $5,000 to $10,000.

For the history of this improvement, see last Annual Report.

The total cost of the improvement to June 30, 1896, has been $334,858.03, at which time there was a good navigable 12-foot channel, which has remained in good shape.

The $10,000 appropriated by the act of June 3, 1896, is being held for emergencies, such as accidents to the piers by storms, ice, etc., requiring renewals, and for dredging as soon as the ruling depth of 12 feet between the piers becomes materially impaired

A fire in August, 1896, almost obliterated the town, destroying all its commercial industries, and wiping out most of the business and residence portions.

Of late years the annual commerce has been roughly estimated at $1,000,000. The great fire, however, destroyed the principal commercial industry, the plant of the Diamond Match Company, and this company has determined not to rebuild.

No appropriation is recommended for the next fiscal year.

Money statement.

July 1, 1896, balance unexpended	*$10,269.97
June 30, 1897, amount expended during fiscal year	590.61
July 1, 1897, balance unexpended	9,679.36
July 1, 1897, outstanding liabilities	8.06
July 1, 1897, balance available	9,671.30

This work is in the collection district of Superior, Mich. Nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich.

Abstract of appropriations for improving harbor at Ontonagon, Mich.

By act of Congress—	
Approved March 2, 1867	$97,600
Approved July 7, 1870	10,000
Approved June 23, 1874	23,000
Approved March 3, 1875	25,000
Approved August 14, 1876	15,000
Approved June 18, 1878	15,000
Approved March 3, 1879	17,000
Approved June 14, 1880	15,000
Approved March 3, 1881	20,000
Passed August 2, 1882	20,000
Approved July 5, 1884	15,000
By act of Congress—	
Approved August 5, 1886	$13,000
Passed August 11, 1888	12,500
Approved September 19, 1890	10,000
Approved July 13, 1892	20,000
Passed August 7, 1894	7,000
Passed June 3, 1896	10,000
Received on account of damage to piers	28
Total	345,128

EXPENDITURES.

Amount expended under the approved project to date	$335,448.64
Balance unexpended July 1, 1897	9,679.36

COMMERCIAL STATISTICS, ONTONAGON, MICH.

During the fall of 1896 a fire destroyed the town and records of Ontonagon, but reports from dock owners there state the business for 1896 was about the same as 1895, which is given below:

Arrivals and clearances of vessels for 1895.

	Arrivals.		Clearances.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	365	69,300	363	60,190
Sail	129	79,000	129	79,000
Total	494	148,300	492	148,190

Arrivals and clearances of vessels for three years.

	1893.	1894.	1895.
Arrivals	†77	211	494
Clearances	77	211	492

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* Twenty-eight dollars deposited August 15, 1895, by United States attorney John Power, account damages to Ontonagon piers by steamer *Owen Sound*. See letter from office Chief of Engineers, January 9, 1897.

† In addition there were a number of arrivals during the season of both steam and sailing vessels seeking refuge during heavy weather, and frequent arrivals of fishing and other tugs.

Principal articles of export and import for 1895.

Imports.	Tons.	Exports.	Tons.
Fish	200	Saw logs	80,000
General merchandise	900	Lumber	94,500
Coal	700	Laths	2,500
		Pickets	2,000
Total	1,800	General merchandise	250
		Total	179,250

Receipts and shipments for three years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1893	178,100	1894	182,790	1895	181,050

G G 6.

IMPROVEMENT AND OPERATING AND CARE OF WATERWAY FROM KEWEENAW BAY TO LAKE SUPERIOR, MICHIGAN.

This work was reported upon in the Report of the Chief of Engineers for 1892 (Appendix III) under the title of "Portage Lake and Lake Superior canals across Keweenaw Point, Michigan," but is locally known and referred to as the Portage Lake Ship Canals.

A full account of the history of this work and its purchase by the United States is given in the above Annual Report.

Maps of this waterway are given in the last Annual Report, pages 2364 and 2365.

The full report of the Board of Engineers, constituted in compliance with the provisions of the river and harbor act of August 5, 1886, is given in the House Executive Document No. 105, Forty-ninth Congress, second session.

This Board submitted estimates for a navigable depth of 16 feet, with a minimum width of 70 feet, to be obtained by dredging wherever required throughout the extent of the waterway, and in addition estimates for an increase, should the future needs of commerce demand it, of the navigable depth to 20 feet, with corresponding increase of width; also estimates of the cost required to provide (for commerce as well as refuge) enlarged and safe entrances from Keweenaw Bay and from the lake. The recommendations of the Board were approved by the Chief of Engineers and the Secretary of War.

The full estimate for the above, including purchase and increase of depth to 20 feet with a width of 120 feet (see page 15 of said Executive Document No. 105), was $2,375,000, of which $350,000 was purchase money, leaving $2,025,000 as estimate for improvement.

The approved project, briefly stated, is as follows: (1) A 16-foot channel of 70 feet bottom width from bay to lake. (2) A renewal of the canal revetments. (3) A reconstruction of the piers at the Lake Superior entrance and their extension to a 30-foot depth of water. (4) The extension of the pier at the Keweenaw entrance to a 20-foot depth of water. (5) At the proper time hereafter to increase the channel depth to 20 feet, with a corresponding width, which should not be less than 120 feet.

At the time of purchase by the United States there was a very poor

13-foot navigation; the channel was narrow and crooked, with many sharp bends; it was poorly marked and lighted; the entrance piers were in a very bad condition; the revetments were rotten, or entirely gone, and there was a heavy tax on the commerce through the canals in the shape of a tonnage charge.

With the $230,000 appropriated by the acts of July 13, 1892, August 7, 1894, and June 3, 1896, the entrance piers have been repaired and put in a good condition; the revetments most necessary for preserving the banks of the canal have been renewed with substantial timber structures; the channel has been deepened to give a good 16-foot navigation at low water datum, with a fair width; many points have been cut away and several bends eased off; Lilly Pond, near the upper entrance, the passing place for vessels and their harbor of refuge, has been widened to 300 feet and a strong bulkhead revetment with mooring posts has been provided, and the tax on commerce has been removed by making it a free canal.

The amount expended to the close of the fiscal year, June 30, 1896, was $176,442.23. At that time the navigable depth was 15 feet, with variable widths. The money expended during the fiscal year ending June 30, 1897, has resulted in giving an additional foot of depth, in widening the channel to approach a uniform width of 70 feet, by dredging, and in preparing plans, specifications, and drawings for the breakwater piers at the upper and lower entrances.

The dredging has been done under contract with Charles S. Barker, of West Superior, dated August 28, 1896, approved September 8, 1896, and is still in force. One hundred and forty-four thousand one hundred cubic yards have been excavated, at 11 cents a cubic yard for soft material and 15 cents a cubic yard for hard material, which are the lowest prices yet paid in this vicinity.

After due advertisement, a contract with Powell & Mitchell, dated April 13, 1897, and approved April 29, 1897, was made for constructing 2,800 linear feet of stone and timber breakwater pier, at $39.10 a foot for Norway pine and $40 a foot for white pine superstructure, at the Keweenaw entrance to the waterway; work to be begun on or before May 1, 1898, to be completed by November 1, 1900, and to cost about $120,000.

The sundry civil act of June 4, 1897, appropriated $350,000 for the improvement of the waterway under the continuing contract system, to be available July 1, 1897. This was too late, however, for the contractors to begin work this season, as all the heavy timber required has to be cut and got to the mill during the winter.

Plans and specifications have been prepared for two large breakwater piers, each about 2,700 feet in length, at the Superior entrance, estimated to cost $450,000. This will be advertised during the next month, and the contract will be made in the fall, work to begin on or before May 15, 1898.

The work already contracted for and that to be contracted for this fall will cost some $565,000, or over 50 per cent of the authorized contracts, which 50 per cent is $532,500. Deduct $350,000 appropriated by the act of June 4, 1897, leaves $182,500, which should be provided for to meet the contracts now in sight, and to be paid for by June 30, 1899. Besides the above, contracts may be made during the coming winter for the renewal of several thousand feet of revetments and for the balance of the dredging to give 16-foot navigable channels with 70 feet minimum width.

The record of vessels and tonnage herewith submitted shows the great amount of commerce using this waterway, and how important a link it is in the chain of lake navigation.

During the last season, that of 1896, the commerce through this waterway has amounted to 1,774 vessels entering and departing, 1,023,979 registered tonnage, and 902,353 net freight tonnage, valued at $30,000,000, not including the local tug business, estimated at $400,000.

The greater relative increase in registered tonnage over the increase in the number of vessels using the waterway shows that a larger class of boats is being operated.

OPERATING AND CARE.

Under authority of the river and harbor act of September 19, 1890, the Secretary of war allotted $8,300 for operating and care of canals and other works of navigation, to be applied to Portage Lake and Lake Superior canals, Michigan, for the fiscal year ending June 30, 1897.

The approved project for the expenditure of this allotment is to maintain the depth obtained by the work of improvement, with a width of 70 feet; to keep a record of the vessels and their tonnage using the canals; to exercise the necessary care in enforcing regulations for the use of the canals; to make frequent surveys to determine changes, and to check up work done in dredging; to guard against encroachments on the legally established harbor lines, and to perform other work incident to the operation and care of the canals. The amount allotted has been expended. An itemized statement is herewith submitted.

Owing to the faulty designs of the existing piers at the entrances and their failure to extend to a proper depth more or less dredging will have to be done each year to maintain the improved channels at these entrances.

A bar forms each year during the winter or early spring at the upper entrance, just outside the piers, and has to be removed by dredging. After removal at the opening of navigation no further trouble is experienced until the next spring. This will be continued until the piers have been extended into deep water.

The usual dredging to the extent of some 48,000 cubic yards was done this spring under the contract with Mr. Charles S. Barker, hereinbefore mentioned.

The railroad and wagon-road bridge across the Portage Lake, between Houghton and Hancock, continues an obstruction to navigation, by reason of the narrowness of the draw openings. A special report on this has been submitted, in which it is recommended that the owners (Houghton County) be required to remove the central pier entirely and substitute for the present drawspan one so constructed as to leave a clear opening to the full width of the present drawspans and center pier.

Location.—The Portage Lake Ship Canals constitute the waterway across Keweenaw Point in the State of Michigan, from Keweenaw Bay to Lake Superior, there being about 25 miles of water route, consisting of 5½ miles of Portage River with its four cuts, 17 miles of Portage Lake, and 2¼ miles in the upper canal from the head of Portage Lake to Lake Superior. They are located in the district of Superior, Michigan, with Houghton, Mich., as the nearest port of entry. There are two regular United States light-houses with range lights at each entrance to the canals from the outside, and range lights at the head of Portage River and at the head of Portage Lake kept by the Light-House Department.

The immediate charge of this waterway has continued under the able management of Mr. G. A. Marr, as assistant engineer and superintendent.

Money statement.

IMPROVEMENT.

July 1, 1896, balance unexpended		$53,557.77
Amount appropriated by sundry civil act approved June 4, 1897		350,000.00
		403,557.77
June 30, 1897, amount expended during fiscal year		13,391.81
July 1, 1897, balance unexpended		390,165.96
July 1, 1897, outstanding liabilities	$10,357.57	
July 1, 1897, amount covered by uncompleted contracts	143,886.22	
		154,243.79
July 1, 1897, balance available		235,022.17
Amount (estimated) required for completion of existing project		715,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		182,500.00
Additional amount required to secure a 20-foot depth		730,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

OPERATING AND CARE OF CANALS.

July 1, 1896, amount allotted for fiscal year 1897	$8,300.00
June 30, 1897, amount expended during fiscal year	8,300.00
July 1, 1897, amount allotted for fiscal year 1898	8,300.00

Abstract of appropriations for improving waterway from Keweenaw Bay to Lake Superior, Michigan.

By act of Congress—

Approved July 13, 1892	$50,000
Passed August 7, 1894	130,000
Passed June 3, 1896	50,000
Approved June 4, 1897	350,000
Total	580,000

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies:

Dredging	$161,000
Pier work, etc	67,000
Purchase of land	2,000
Total	230,000

Abstract of proposals received by Maj. Clinton B. Sears, Corps of Engineers, and opened at Duluth, Minn., July 31, 1896, for dredging in Portage Lake ship canals, Michigan.

No. of bid.	Name and address of bidder.	Dredging sand and soft material (200,000 cubic yards), per cubic yard.	Dredging hardpan and stiff clay (40,000 cubic yards), per cubic yard.	For use of dredging plant (per hour).	Total.
		Cents.	*Cents.*		
1	C. E. Mitchell & Co., Ludington, Mich	11.8	19.7	$7.90	$31,480
2	Chas. S. Barker, West Superior, Wis	11	15	9.00	28,000
3	Williams, Green & Williams, Duluth, Minn.	12.5	22.5	10.00	34,000
4	James Pryor, Houghton, Mich	15	24.5	10.00	39,800

Abstract of proposals received at Duluth, Minn., for building pier extension at the Keweenaw Bay entrance to Portage Lake ship canals, Michigan, opened March 31, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	2,800 feet pier extension (more or less).		If small stones are used instead of brush mattress—	
		Superstructure to be of Norway pine (per linear foot).	Superstructure to be of white pine (per linear foot).	Add to price bid (per linear foot).	Deduct from price bid (per linear foot).
1	Samuel Meniece, Duluth, Minn	$55.50	$58.50		$1.00
2	Porter Bros., Duluth, Minn	49.14	49.47		.40
3	King & Steele, Duluth, Minn	52.00			
4	Powell & Mitchell, Marquette, Mich	39.10	40.00		.40
5	Winston Bros., Minneapolis, Minn	52.40	54.80	$0.70	.70
6	Eslow & Munroe, Charlevoix, Mich	50.39	51.19		.50
7	James Pryor, Houghton, Mich	44.00	44.92		.49
8	Chicago Star Construction and Dredging Co., Chicago, Ill	61.05	62.05		1.00
9	Heldmaier & Neu, Chicago, Ill	46.34	47.07		
10	McArthur Bros. Co., Chicago, Ill	65.70	66.79		2.00
11	Lipsett & Gregg, Sault Ste. Marie, Mich	51.25	52.25		
12	James Sullivan and William W. Lavanway, Duluth, Minn	4,847.61	4,998.62		.51
13	C. E. Mitchell & Co., Ludington, Mich	66.50	66.50		
14	Alex. McCurdy, Duluth, Minn., and William McCurdy, Houghton, Mich	50.70	52.64		.72
15	Green & Anderson, Green Bay, Wis	56.09	56.96	.50	
16	James A. Burke, West Superior, Wis	51.736	51.886		.80
17	Butler-Ryan Co., St. Paul, Minn	56.25	57.75		
18	P. McDonnell, Duluth, Minn	46.10	47.10		
19	A. & D. Sang, Duluth, Minn	59.85	62.15		.75

Abstract of existing contracts.

With Charles S. Barker, of West Superior, Wis., for dredging (about 40,000 cubic yards), dated August 28, 1896, approved September 8, 1896; work commenced September, 1896, to be completed October 1, 1897.

Powell & Mitchell, of Marquette, Mich., for building 2,800 linear feet of pier extension at the lower entrance; contract dated April 13, 1897, approved April 29, 1897; to be commenced by May 1, 1898, and completed by November 1, 1900.

COMMERCIAL STATISTICS.

Statistics of vessels passing through the canals during the calendar year 1896.

	Bound up.		Bound down.	
	Number.	Net tonnage.	Number.	Net tonnage.
Steam	804	519,300	469	245,713
Sail	362	190,175	139	68,791

Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1896.

Bound up.	Net tons.	Bound down.	Net tons.
Coal	398,864	Copper	56,187
Manufactured iron	14,172	Grain	2,605
Salt	14,259	Flour	77,414
Limestone	18,998	Wheat	6,763
Copper	18,286	Pig iron	8,032
Miscellaneous merchandise	117,553	Iron ore	16,755
		Lumber	161,862
Total	582,132	Miscellaneous merchandise	7,174
Passengers, number	20,901		
		Total	336,792
		Passengers, number	20,361

Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1896—Continued.

RECAPITULATION.

	Bound up.				Bound down.			
	1896.		1895.		1896.		1895.	
	Total.	Upper canal.	Total.	Upper canal.	Total.	Upper canal.	Total.	Upper canal.
Number of vessels	1,166	818	1,105	726	608	334	626	314
Net tonnage	709,475	571,816	673,688	550,629	314,504	191,814	283,091	205,087
Freight ... tons	582,132	238,756	514,713	323,219	336,792	260,014	307,249	262,842
Passengers ... number	20,901	16,510	12,653	8,474	20,361	16,055	12,156	8,199

Statistics of tugs passing through the canals during the year 1896.

	Bound up.	Bound down.
Trips ... number	891	904
Net tonnage ... tons	26,449	26,070
Vessels ... number	56	27
Scows ... do	180	184
Rafts ... do	85	189
Booms ... do	177	68
Logs ... M feet	8,294	30,821
Lumber ... do	1,841	10
Timber ... do	9,165	11,507
Cord wood ... cords	552	291
Building stone ... tons	4,674	....
Coal ... do	....	100
Miscellaneous ... do	320	1,406

Local business of tugs in Portage Lake during the year 1896.

Bound up.	Total.	Bound down.	Total.
Trips ... number	829	Trips ... number	830
Net tonnage ... tons	14,988	Net tonnage ... tons	15,007
Scows ... number	648	Scows ... number	656
Rafts ... do	82	Rafts ... do	24
Booms ... do	35	Booms ... do	21
Logs ... M feet	1,765	Lumber ... M feet	3,460
Lumber ... do	2,158	Timber ... do	1,460
Timber ... do	650	Cord wood ... cords	10,268
Cord wood ... cords	5,441	Mineral, copper ... tons	709
Building stone ... tons	88	Charcoal ... bushels	129,650
Ties ... number	900	Poles ... cords	280
Vessels ... do	3	Logs ... M feet	540
Old iron ... tons	251	Hay ... tons	100
Miscellaneous ... do	738	Clay ... do	150
		Brick ... M	80,000
		Miscellaneous ... tons	545

Statistics of vessels passing through the Upper Canal (Portage Lake ship canals) during the year 1896.

	Bound up.	Bound down.
Steam	570	252
Net tonnage	448,109	156,738
Sail	248	82
Net tonnage	123,707	85,076
Cargo ... tons	238,756	260,014
Passengers ... number	16,510	16,055

Statistics of vessels passing through the Upper Canal (Portage Lake ship canals) during the year 1896 —Continued.

RECAPITULATION (PORTAGE LAKE SHIP CANALS).

Bound up and down.	1892.	1893.	1894.	1895.	1896.	Increase over 1895.
Total number of vessels	1,470	1,408	1,724	1,731	1,774	43
Total net tonnage	665,063	669,510	860,618	956,779	1,023,979	67,200
Total freight ....tons..	496,288	532,628	754,973	821,962	918,924	96,962
Total passengers ....number..	30,093	27,084	32,636	24,809	41,262	16,453

Items.		Price per unit.	Total valuation.	
			1895.	1896.
Coal	net tons..	$3.65	$1,148,161.00	$1,456,218.60
Flour	barrels..	3.85	3,400,380.00	2,980,450.55
Wheat	bushels..	.75	182,847.00	169,072.59
Grain (other than wheat)	do....	.39	37,713.20	39,207.87
Manufactured iron	net tons..	50.00	851,250.00	708,600.00
Pig iron	do....	13.50	119,799.00	108,432.00
Iron ore	do....	3.25	62,755.00	54,453.75
Salt	barrels..	.75	45,028.00	74,859.75
Copper	net tons..	200.00	13,980,800.00	14,894,600.00
Lumber and timber	M feet B. M..	12.50	1,541,250.00	1,293,800.00
Logs	do....	9.00	285,453.00	352,035.00
Building stone	net tons..	10.00	100,600.00	146,740.00
Limestone	do....	1.50	18,511.50	28,497.00
Unclassified freight	do....	60.00	8,057,820.00	7,646,820.00
		....	29,832,367.70	29,953,787.02

The following table gives the principal lines of steamers using these canals during the season of 1896:

Lake Michigan and Lake Superior Transportation Co., Chicago, Ill	5
The Erie and Western Transportation Co. (Anchor Line), Buffalo, N. Y	17
The Western Transit Co., Buffalo, N. Y	12
The Union Transit Co., Buffalo, N. Y	7
The Jenks Shipbuilding Co., Port Huron, Mich	3
The Mills Transportation Co., Marysville, Mich	9
The Pawnee Boat Co., Port Huron, Mich	4

In 1897 there have been a few changes, and the following table shows the principal lines:

Lake Michigan and Lake Superior Transportation Co., Chicago, Ill	5
The Erie and Western Transportation Co. (Anchor Line), Buffalo, N. Y	17
The Western Transit Co., Buffalo, N. Y	12
The Union Transit Co., Buffalo, N. Y	7
The Jenks Shipbuilding Co., Port Huron, Mich	3
The Whitney Transportation Co., Detroit, Mich	8
The Vulcan Transportation Co., Detroit, Mich	4
The Hope Transportation Co., Detroit, Mich	3

The above list only gives some of the principal regular transportation lines using these canals. The vessels of many individual and other lines and many large steel steamers and barges are now using these canals frequently, and also steam barges with two or three vessels in tow quite regularly. There is the usual local business of tugs towing vessels, rafts, and loaded scows.

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation (indefinite), act of July 5, 1884, applied to Portage Lake and Lake Superior canals during fiscal year 1897.

Date.		No. of voucher.	Name.	Designation.	Amounts.
1896.					
July	31	36	Joseph Slock	Storage	$2.00
	31	37	J. H. Rice	Rent	19.00
	31	38	Pay roll	Services	344.17
Aug.	10	7	Maj. C. B. Sears, C. of E	Mileage	39.34
	31	27	J. H. Rice	Rent	19.00
	31	28	Joseph Slock	Storage	2.00
	31	29	Pay roll	Services	362.00
Sept.	30	44	J. H. Rice	Rent	19.00
	30	45	Joseph Slock	Storage	2.00
	30	51	Pay roll	Services	267.00
Oct.	26	(pt.) 40	Duluth Paper Co	Stationery	(pt.) 14.11
	31	54	J. H. Rice	Rent	19.00
	31	55	Joseph Slock	Storage	2.00
	31	59	Pay roll	Services	237.00
Nov.	2	19	Carlton Hardware Co., F. S. Carlton, president and treasurer.	Hardware	37.20
	18	23	Duluth Paper Co. (pt.)	Stationery	5.20
	30	39	J. H. Rice	Rent	19.00
	30	40	Joseph Slock	Storage	2.00
Dec.	1	1	Pay roll	Services	279.50
	12	14	Andrew B. Graham	Maps	16.50
	31	31	Joseph Slock	Storage	2.00
	31	32	J. H. Rice	Rent	19.00
	31	34	Pay roll	Services	257.00
1897.					
Jan.	10	8	La Vaque Paint and Wall Paper Co	Plate glass	5.55
	31	26	J. H. Rice	Rent	19.00
	31	27	Joseph Slock	Storage	2.00
	31	28	Pay roll	Services	127.00
Feb.	2	3	Paul Mondor	do	30.00
	27	21	Maj. C. B. Sears	Mileage	39.34
	28	29	J. H. Rice	Rent	19.00
	28	30	Joseph Slock	Storage	2.00
	28	31	Pay roll	Services	157.00
Mar.	31	40	do	do	157.00
	31	41	J. H. Rice	Rent	19.00
	31	42	Joseph Slock	Storage	2.00
Apr.	30	40	Pay roll	Services	178.00
	30	41	Joseph Slock	Storage	2.00
	30	42	J. H. Rice	Rent	19.00
May	4	6	Sam S. Robinson	Tug hire	19.50
	14	30	Charles S. Barker	Dredging	302.12
	31	41	Pay roll	Services	325.00
	31	44	Joseph Slock	Storage	2.00
	31	48	J. H. Rice	Rent	19.00
June	2	5	Sam S. Robinson	Tug hire	96.00
	4	13	Charles S. Barker	Dredging	3,806.75
	16	(pt.) 34	Harvey C. Beeson	Directory	5.00
	16	33	Charles S. Barker	Dredging	672.72
	30	56	Pay roll	Services	135.00
	30	60	Sam S. Robinson	Tug hire	120.00
	30	59	Joseph Slock	Storage	2.00
	30	58	J. H. Rice	Rent	19.00
	30	57	James R. Dee	Telephone	18.00
					8,300.00

G G 7.

IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

Originally this harbor was entirely unprotected from northeast storms.

Projects were adopted in 1868 and 1888 for the erection of a breakwater composed of timber cribs ballasted with rock, and extending from the shore into the bay, a distance of 3,000 feet. This breakwater was completed, practically as proposed, in 1894, at a total cost of $469,732.44, including repairs.

Owing to the general decay of a large portion of the original superstructure, and the certainty that the whole of it would have to be renewed every twenty or twenty-five years, a project for a concrete superstructure for the whole breakwater was approved February 27, 1890. This project was estimated to cost $232,936.71.

Work on this was begun in the spring of 1895, and 860 linear feet of it completed by the close of navigation in 1896. Of this, 390 linear feet was built during the fiscal year, 1896-97. (For detailed description of this work, with drawings, cost, photographic views, etc., see the last Annual Report, pp. 2365-2385.)

The experience gained in building the above demonstrated the great difficulty of putting in, at and below the water surface on the lake side, the footing at the toe of the lower slope, owing to the irregularity of the cribs, and the almost constant wash from the surge of the sea. It was determined to change the construction of this part by using blocks of concrete instead of monolithic concrete *in situ.*

As it was necessary that these blocks should have sufficient hardness to stand handling, and as a delay in their construction until warm weather would postpone the main work, designed to rest on their inner edges to very late in the working season, at best very short, it was arranged to build these blocks under cover to avoid freezing during the winter. This was successfully accomplished at small cost, considering the excellent results obtained, and by spring we had forty blocks with hard, smooth faces and sharp edges, and which, when struck with a hammer, gave a clear, sonorous ring, showing great homogeneity.

As soon as the weather would permit, preparations were made to build 140 linear feet of the main work, this being all the funds on hand would justify. Up to June 30, 1897, 140 feet of the old superstructure had been cut away and leveled to 1 foot below low-water datum, 28 foot blocks had been successfully laid, the foundation course had been completed, and work on the monolithic blocks begun.

For the details of the work, for the analytical cost of construction, and for the results of two years of cement testing attention is invited to the very instructive and complete report presented herewith by Mr. Clarence Coleman, assistant engineer, together with the accompanying drawings, tables, and photographs, the publication of which is strongly recommended as of professional interest.

Mr. Coleman has continued his successful management of the work, and is to be commended for the zeal, ingenuity, and ability which have marked his administration as local engineer.

The amount expended on this harbor up to June 30, 1896, was $503,316.96. The results have been the complete protection of the ore, coal, lumber, and commercial docks from storms.

The results due to the expenditure during the fiscal year ending June 30, 1897, have been to make permanent 390 feet more of the breakwater which affords this protection, thus dispensing with renewals every twenty years.

Owing to the shortness of the working season during which concrete can be laid safely—only five months—it is very desirable to have an appropriation large enough to keep up work with a full force throughout at least two working seasons.

The work has been carried on by hired labor, the material having been purchased by contract after due advertisement. The growth of the commerce of this port was steady and quite marked up to 1892, when, owing to the general business depression, it showed a decline. It is now increasing, however.

During the fiscal year ending June 30, 1872, there were 780 arrivals and clearances of vessels, with a registered tonnage of 370,000 tons.

In 1896 there were 2,064 arrivals and clearances, with a registered tonnage of 1,586,184 tons. In twenty years the commerce of the port has amounted to at least $73,000,000.

Money statement.

July 1, 1896, balance unexpended	$30,240.80
June 30, 1897, amount expended during fiscal year	22,045.45
July 1, 1897, balance unexpended	8,195.35
July 1, 1897, outstanding liabilities	1,147.98
July 1, 1897, balance available	7,047.37
Amount (estimated) required for completion of existing project	198,936.71
Amount that can be profitably expended in fiscal year ending June 30, 1899	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Abstract of appropriations for improving harbor at Marquette, Mich.

By act of Congress—	
Approved March 2, 1867 (allotment)	$85,000
Approved April 10, 1869 (allotment)	26,730
Approved July 11, 1870	25,000
Approved March 3, 1871	60,000
Approved June 10, 1872	50,000
Approved March 3, 1873	15,000
Approved June 23, 1874	15,000
Approved March 3, 1875	15,000
Approved June 18, 1878	2,000
Approved August 14, 1878	2,000

By act of Congress—	
Approved March 3, 1879	$1,500
Approved June 14, 1880	1,000
Passed August 2, 1882	16,000
Approved July 5, 1884	5,000
Approved August 5, 1886	10,000
Of August 11, 1888	25,000
Approved September 19, 1890	40,000
Approved July 13, 1892	80,000
Passed August 7, 1894	30,000
Passed June 3, 1896	29,000
Total	533,230

Name of harbor, Marquettee Harbor, Michigan. Collection district, Marquette, Mich. Nearest light-house, Marquette, Mich.

COMMERCIAL STATISTICS, MARQUETTE, MICH.

Year.	Arrivals.	Clearances.	Tonnage.
1893	661	661	594,900
1894 (steam, 660; sail, 256)	916	916	900,306
1895 (steam, 543; sail, 254)	797	797	915,800
1896 (steam, 692; sail, 340)	1,032	1,032	1,586,184

Principal articles of export and import.

Exports.	Tons.	Imports.	Tons.
Iron ore	1,565,227	Coal	182,000
Pig iron	8,280	Oil	1,353
Lumber	68,460	Brick	1,000
General merchandise	3,500	General merchandise	1,619
		Flour	622
Total	1,645,467	Total	186,594

Vessel tonnage.

Year.	Tonnage.	Average tonnage.
1896	1,586,184	1,587
1895	915,800	1,400
Increase	670,384	137

Comparative statement of receipts and shipments for two years.

Year.	Tons.	Year.	Tons.
1896	1,832,061	1895	1,320,050

Arrivals and clearances of vessels for five years.

Year.	Arrivals.	Clearances.	Tonnage.	Year.	Arrivals.	Clearances.	Tonnage.
1892	782	788	1,474,002	1895	797	797	915,800
1893	661	661	594,900	1896	1,032	1,032	1,586,184
1894	916	916	900,306				

REPORT OF MR. CLARENCE COLEMAN, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Marquette, Mich., June 20, 1897.

MAJOR: I have the honor to submit herewith the following report of operations in connection with the construction of the concrete superstructure to the United States breakwater at Marquette, Mich., from the 1st of December, 1895, to the 30th of November, 1896, inclusive dates, and also a supplemental report showing the methods adopted and the cost of making certain monolithic concrete foot blocks during the winter of 1896–97, which are now being used in the subaqueous foundation under the standard monoliths on the lake front of the breakwater.

The work of construction was commenced in the latter part of May, 1896, with a small force, assembling the plant and making repairs to concrete which was damaged by wreckage during the heavy storm of September 29, 1895, before the concrete had thoroughly set.

While the amount of material used in repair was small, the work was necessarily of a tentative character, special shield and forms being required to render it effective and permanent.

The cost of construction of all the special devices for accomplishing this work is included in the labor column, Table 1, Sheet D.

Stone screenings, obtained by screening the broken stone, were used in making these repairs, as well as for the gallery floor, and to some extent in finishing the banquet and parapet of the monolithic superstructure.

These screenings are charged in Table 1, Sheet D, at the cost of the same volume of sand required to fill the voids in the stone occasioned by their removal.

REMOVING THE OLD SUPERSTRUCTURE.

Removal of the timber superstructure was commenced June 9, 1896, and the same methods used as during the season of 1895. The cost was somewhat increased as the shore end of the breakwater was approached, on account of being inaccessible to the floating derrick. A total volume of timber and stone amounting to 2,249 cubic yards was removed, at a cost of $0.449 per cubic yard, or 337.4 linear feet of superstructure, at $2.99 per linear foot.

It must be borne in mind that not less than one-tenth of this material was taken from below the water level, the maximum depth being 1 foot below the low-water datum. The main volume of the heavy stone removed was loaded on scows and used in riprapping the cribs on the harbor side of the breakwater. A volume of 214.27 cubic yards of this rubblestone, measured in its solidity, was used in the interior of the concrete monoliths. The timber from the old superstructure was rafted and afterwards piled on shore and used for fuel and a variety of purposes in construction.

SUBAQUEOUS CONCRETE.

The plan for putting in the subaqueous concrete foundation for the monoliths was, with your approval, modified from that used in 1895, as it was believed that a large amount of the most costly concrete could be saved by using concrete in bags, placed as shown on Sheet E, accompanying this report. The economic features of this method of construction consist in the reduction of the volume of concrete by leaving the center of the floor of rubblestone, upon which the concrete rests, higher than the sides, and the protection of the concrete, before the setting of the cement, from the action of waves and currents by the interposition of the burlap bags.

It is estimated that for the remainder of the work a volume of concrete amounting to 1,695 cubic yards can be dispensed with by this method, and the cost of removing an equal volume of rubblestone eliminated; assuming the cost of the concrete at $6 per cubic yard, and cost of removing rubblestone under water at $0.50 per cubic yard, would represent a saving of $11,017.50 for the balance of the work.

The bags used in this construction were of 8-ounce burlap, and they were made 6 feet in length and 80 inches in circumference. As filled with concrete, they weighed about 2,000 pounds each. They were filled at the mixing platform, while lying in position on a specially-designed skip constructed to hold one bag. As the bags were filled they were swung onto the cars by means of a gallows frame and tackle. The car when loaded was run out to the work, where the skips were handled with the floating derrick, and after resting on the bottom the skips were tripped in such a manner as to place the bags in the required position with a minimum disturbance of their contents. Sheet E shows the position of these bags when placed. Another decided advantage in the bag construction was the facility with which the foundation could be built out on, and flush with the face of the crib wall timbers on both harbor and lake sides. It is believed that this method of construction possesses superior advantages for both economic and constructive reasons, the increased cost of handling the concrete being more than compensated by the economy in concrete and handling the rubblestone and the advantages in construction already mentioned.

The details of the cost of the subaqueous Portland cement concrete foundation are as follows:

453 barrels Portland cement, at $2.627	$1,190.03
375 cubic yards broken stone, at $1.619	607.13
180 cubic yards sand, at $0.392	70.56
Twine and needles	6.36
3,220 yards 8-ounce burlaps, at $0.03304	106.39
Total cost of material	1,980.47

Cost of mixing, filling bags, and loading cars.

Superintendence	$12.55
Master laborer, 108 hours, at $0.21875	23.42
Laborers, 1,750 hours, at $0.175	306.25
Total cost of mixing, etc	342.22

Transportation.

Superintendence	$5.25
Laborers, 306 hours, at $0.175	53.55
Total cost of transportation	58.80

Depositing in place.

Superintendence	$13.25
Steam engineer, 108 hours, at $0.25	27.00
Master laborer, 108 hours, at $0.21875	23.42
Laborers, 510 hours, at $0.175	89.25
Total cost of depositing	152.92

From the foregoing we have, as cost per cubic yard of concrete in place—

For materials ($1,980.47÷375)	$5.2812
For mixing and filling bags ($342.22÷375)	0.9125
For transportation ($58.80÷375)	0.1568
For depositing ($152.92÷375)	0.4077
Total cost per cubic yard of concrete in place	6.7582

Or $1.4770 as the cost of labor and superintendence per cubic yard and $5.2812 as the cost of materials per cubic yard. The concrete in bags was of the same proportions of stone, sand, and cement as the concrete used in the subaqueous work during the season of 1895. (See Report of the Chief of Engineers, 1896, Appendix H H, p. 2370.)

A very interesting and satisfactory demonstration of the efficiency of this character of work was offered in the month of May, 1896, when the small sacks of concrete with which the exposed surface of one of the cribs had been temporarily covered for protection during the winter months were removed.

The matrix of the stone in these sacks was composed of a mixture of 1 of Portland cement to 4 of sand by weight, and the sacks were placed on the rubblestone of the crib, which had been cut down to 1 foot below the low-water datum, to prevent the washing out of the stone by the winter storms. Only one layer of these sacks, laid slightly overlapping from the lake side of the crib, was used. The sacks were so lightly filled that when laid as described the average thickness of the concrete covering was not more than 6 inches. The crib was storm-swept many times without displacing a single sack, and when they were removed in the following spring to facilitate the work they came away, when pulled up with the floating derrick, a dozen or more at a time, so firmly were they cemented together, and in many cases large rubblestones were lifted up along with them, because of the adhesion of the cement to their surfaces.

It was determined before the commencement of the working season, with your approval, to abandon the plan pursued in 1895 of mixing the concrete on scows alongside the work, and thus eliminate the cost of transporting the materials for each day's work on cars to the scows. To this end a mixing platform was constructed immediately adjacent to the stone and sand bins and convenient to the cement warehouse. The supply of materials to the mixers was readily kept up by three laborers. The mixing platform was constructed at the same elevation as the floors of the stone and sand bins, so that the measuring carts could be loaded in the bins and run directly onto the mixing floor, and the railroad track for transporting the concrete out to the work was built with a level grade of such elevation that the cars passed under the platform, receiving their loads through a slot in the platform.

These cars, carrying a cubic yard of concrete, were readily propelled by two men out to the work, the same men assisting in the work of loading and unloading. For the length of the haul, which did not exceed 600 feet, this method was very economical. The loading of the cars at the mixing platform for all of the concrete, except that in bags, generally required three-fourths of a minute to the cubic yard.

The plan of mixing and the proportion of sand, stone, and cement used were exactly as described for the preceding season. (Report of the Chief of Engineers, U. S. A., for 1896, Appendix H H, p. 2372.)

The experience and observation for two seasons with concrete made under the formulæ given in that report do not suggest any innovations on the methods used.

CONSTRUCTION OF THE MONOLITHIC BLOCKS.

During the season of 1896 it was considered expedient to still further reduce the cross section of the monoliths as the shore was approached, and, acting under your instructions, this was accordingly done from Block No. 74 to 86, inclusive, as shown on Sheets A and E. The concrete, being mixed and transported on cars as before described, was shoveled into the forms, where it was thoroughly compacted with the 36-pound iron rammers. It is believed that shoveling the concrete in place possesses a very decided advantage over dumping it in quantity, as by the former method the danger of forming alternate stratifications of the coarse and fine material is effectually prevented. Plate No. 45, accompanying this report, shows the arrangement of trestles, tracks, etc., with car in position for delivering concrete into an intermediate form.

The block in foreground, showing gallery, is an isolated block, and the next block in perspective is an intermediate, which had just been filled.

The materials used in construction of the concrete superstructure in 1896 were partly from the stock carried over from 1895 and partly from stock purchased in 1896. The prices paid being different, an average price for all the materials used in 1896 obtains.

The following statement shows the cost of items in detail for the monolithic blocks, including materials, labor, and superintendence. The cost of handling the rubblestone is included in the cost of the item of labor for depositing:

1,780 barrels natural cement, at $1.068	$1,901.04
963.5 cubic yards broken stone, at $1.619	1,559.91
53.5 cubic yards stone screenings, at $0.392	20.97
485.613 cubic yards sand, at $0.392	190.36
214.27 cubic yards rubblestone (cost of handling).	
1,125 pounds tarred paper, at $0.0107	12.07
4,075 pounds iron, at $0.015	61.12
76 linear feet ¼-inch gas pipe, at $0.035	2.66
6 linear feet 6-inch gas pipe, at $0.25	1.50
2 dozen papers 14-ounce tacks, at $0.40	.80
	3,750.43

The cubical volume of the monolithic blocks constructed in 1896 is 1,231.528 cubic yards. Then the cost of materials per cubic yard equals $3,750.43÷1,231.528=$3.045.

The cost of labor and superintendence for mixing and depositing the concrete in the monoliths was as follows:

Mixing.

Superintendence	$18.20
Master laborer, 254 hours, at $0.21875	55.56
Laborers, 4,470 hours, at $0.175	782.42
	856.18

Transporting and depositing.

Superintendence	$34.98
Overseer, 35 days, at $2.33⅓	81.67
Laborers, 1,949 hours, at $0.175	342.07
	458.72

From the above we have as the cost per cubic yard—

For mixing ($856.18÷1,231.528)	$0.695298
For depositing ($548.72÷1,231.528)	.372480
Total cost labor and superintendence per cubic yard	1.067778
Total cost of material per cubic yard	3.045
Cost of labor, superintendence, and material	4.113

The cost of other items of labor and materials auxiliary to all of the concrete work is shown on sheet D, Table No. 2.

While these items are charged to concrete put in place in 1896, it is readily seen that the exact relation of many of these items to the cost of concrete in any single season of the work can not be correctly determined, as the expenditure frequently has reference to work contemplated in the future and can only be properly distributed when the construction of the entire superstructure has been completed.

Table No. 5, sheet D, shows the total amount charged to concrete from December 1, 1895, to November 30, 1896, both dates inclusive, as $15,175.12, and Table No. 1, sheet D, shows the total number of cubic yards of concrete put in place for the same period to be $1,797.668. Hence for the cost per cubic yard of all the concrete in 1896 we would have 15,175.12÷1,797.668=$8.441, or for the cost per linear foot of the superstructure built in 1896 we would have $15,175.12÷390=$38.910.

The increase in cost of the principal items for 1896 over 1895 may be stated as follows:

Percentage of increase in cost of—	Per cent.
Labor, 1896	12.00
Portland cement, 1896	19.41
Natural cement, 1896	2.69
Broken stone, 1896	2.46

The only change suggested by experience in molding the monoliths is the lining of the slope pieces of the forms with No. 8 sheet steel. This modification having been approved by you, will be used during the present season. It is believed that the steel lining will enable the molders to perform their work very perfectly and produce very smooth surfaces on the slope of the blocks by preventing sharp, angular pieces of stone from penetrating the surfaces of the molds, and thus interfering with and increasing the labor of compacting the concrete. The use of the lining should also very greatly increase the life of the forms. A new concrete form for molding the standard monoliths has been built, which will very greatly facilitate the work of construction.

The details of construction and manipulation of the concrete forms having been fully described, as well as the manner in which the blocks are molded (see Report of the Chief of Engineers, U. S. A., for 1896, part 4, p. 2374), any further description would be superfluous.

The work of molding the monoliths was commenced on July 10 with block No. 48, and was completed on September 16 with block No. 86, which reaches the point at which the monolithic finish for the shore end, as shown on sheet B, will be located. It was not deemed desirable to construct this approach to the breakwater and entrance into the closed gallery until the completion of the concrete superstructure, as the elevation of the approach would prove a hindrance to the transportation of materials out to the work.

A plan showing all of the details of the proposed finish at the north or shore end is submitted herewith, marked Sheet B, and also drawings of the proposed finish to the concrete superstructure on the south or water end, where the present light-house is located. This is designed and proportioned to conform to the present light-house structure, all of which has been done under your direction and with your approval.

The foundation and widening of the rock embankment at the outer end to give the necessary width for another crib on the harbor side was commenced last October, and will probably be brought up to the proper grade during the present season, thus giving time for settlement before it is loaded with the concrete superstructure. The stone used in the base of this embankment was taken from the lake side of the concrete work, much of it being below the water level of the lake. There is still a large amount of stone in the same locality which might be removed in very favorable weather at a small cost.

The meteorological conditions prevailing during the season of 1896 were unfavorable to this class of work The change in the lake level during the season was from low-water datum + 0.18 feet in March, 1896, to low-water datum + 1.36 feet in August; but the diurnal variations were of great frequency and very extreme in their character during the prosecution of the concrete work. The prevalence of easterly winds caused much rough water and consequent delays. No storms of very marked violence occurred until the 30th of October, when a severe northeast storm prevailed, which caused an undertow of such intensity in the harbor as to greatly endanger craft of every description lying in at the time. Vessels at the docks were compelled to cast off and go to anchor, and in some cases dragged their anchors, and were only prevented from going on the beach by the prompt assistance of the harbor tugs. The three scows used on this work broke from their fastenings and were all water-logged by the storm. As two of these scows carried valuable engines, etc., and the season being at hand when great damage might have been inflicted by freezing temperatures, it was necessary to act promptly in raising and securing them. Plates Nos. 28, 32, and 35, accompanying this report, were obtained during the storm of October 30, and Plates Nos. 31 and 34 were taken during the occurrence of a severe storm on November 7. They are illustrative of the violence of the waves on the exposed front of the breakwater.

During the prevalence of similar storms I have known cases in which stones weighing as much as 500 pounds were brought up from the bottom of the lake by wave action out of water with a normal depth of not less than 10 feet and landed on the banquette of the superstructure, and many of less weight are frequently carried entirely over the parapet of the superstructure into the water on the harbor side. In the same manner it is noticed that during the winter storms, when the water on the harbor side is covered with heavy ice, that a very considerable amount of sand and gravel is carried over by the waves and deposited on the ice at a distance of from 20 to 40 feet away from the harbor face of the concrete work. Continued observations as to the effect of heavy waves striking the concrete work have failed to detect any vibration as the result of such impact. These observations have been mainly made during the greatest storms from the closed gallery, selecting those points where the waves seemed to strike with the greatest force. With the ear placed against the gallery wall on the sea side a very minute vibration should be apparent. The thermal conditions which prevailed during the winter months were very severe, and storms were of frequent occurrence. Plate No. 71 is illustrative of a very low temperature causing vaporization of the water at the surface of the lake. It was taken during January, 1897, with temperature at —16° F.

Plate No. 59 was obtained during a very heavy storm on February 22, 1897, when huge masses of ice were being carried over the concrete work by the waves.

Plate No. 55 shows very clearly the conditions which prevailed along the lake side of the concrete superstructure on February 23, the day after the storm just mentioned. As the storm subsides the ice forms in immense masses on the concrete superstructure, in some places rising to a height of 10 feet above the parapet of the superstructure No. 55 was taken from a point near the south end of the concrete work looking shoreward.

Plate No. 70 was taken from a point on the frozen surface of the lake immediately in front of the concrete work and about 200 feet distant from it, and illustrates how the entire concrete superstructure is enveloped with ice as the winter advances. That portion of the concrete superstructure which was built in 1895 has now been exposed to the storms and great extremes of climatic conditions which prevail in this latitude for two years, and seems fully capable of resisting their influences. Plate No. 39 shows the concrete superstructure as completed September 16, 1896, from the shore end looking south. Plate No. 40 is a view from the south end looking north taken same date, and Plate No. 41 is a view along the lake front of the concrete superstructure of same date.

TESTING CEMENT AND OTHER MATERIALS.

Cement testing has been confined to the cements used in the work, and may be classified as follows: Fineness, time of setting, constant volume, specific gravity, and tensile strength. The apparatus used in testing consisted mainly of a 1,000-pound Riehle testing machine, briquet molds of standard pattern of the American Society of Civil Engineers, a cast-iron mixing box of the pattern described in the Report of the Chief of Engineers, U. S. A., 1892, part 3, page 2416, weighing scales graduated to weigh $\frac{1}{100}$ of 1 gram, a set of counter scales, cubic centimeter graduated glass, two tables with heavy slate slabs, a set of sieves from No. 10 to No. 100, $\frac{1}{12}$-inch wire weighted to one-fourth pound, $\frac{1}{24}$-inch wire weighted to one pound, two wooden tanks with briquet frames, capacity of 2,000 briquets, each made after the pattern described in the Report of the Chief of Engineers, U. S. A., 1893, Vol. 2, part 4, page 3009, a damp closet, hot-water tank with lamp for heating, steel dies for stamping numbers on briquets, trowels, sample cans, maximum and minimum thermometers, and other small accessories. The laboratory or testing room was constructed in the end of the warehouse between the office and a rear room used for storing cement samples and other small articles. The ceiling, floor, and walls of this room were underlaid with heavy paper in addition to the regular matched boards. The room was heated with a sheet-iron stove of the air-tight pattern during the cold weather and an oil stove was used in very mild weather.

The tanks were placed in brackets up near the ceiling, so as to be well out of the way and at the same time receive the benefit of the heated air in the upper part of the room.

Doors from the cement-testing room give access to the rooms on each side and the cement warehouse.

Plate 76, accompanying this report, is an interior view of the laboratory, and shows some of the apparatus used in testing.

The temperature of this room was maintained at from 60° to 80° F. The barrels of cement, as received at the warehouse, were numbered and piled; a sample, taken from every number exactly divisible by ten, was put into a tin can, numbered to correspond with the barrel from which it was taken, and shelved for testing. A sample auger was used of sufficient length to reach the center of each barrel.

For the regular tests prescribed by the specifications, 3 pats of neat cement on glass and 15 briquets were made from each sample of Portland cement, and 3 pats on glass and 15 briquets from each sample of natural cement.

The pats in both cases were tested for time of setting, and after twenty-four hours in the damp closet one pat was subjected to immersion in water at 212° F. for eight hours, another was immersed in water at temperature of 60° F. for one month, and a third was kept in air temperature of testing room for one month, the requirement being that these pats should show no distortion or cracking after these tests.

In the boiling tests the pats frequently came off the glass; but this is a severe test, and the ebullition of the water acting upon the glass and causing it to vibrate on the bottom of the tank probably caused the pats to separate from the glass.

Samples from every fiftieth barrel of both Portland and natural cements were tested for fineness with No. 50 and No. 100 sieves. For the tests for tensile strength 15 briquets were made from each sample, to be broken in sets of 5 after seven days, twenty-eight days, and six months.

Prior to December 1, 1896, all mixing for briquets was done upon a slate slab with a trowel, and subsequent to that time the cast-iron mixing box with German clod hoe was used. The time required for mixing and molding five briquets with the trowel on the slab was generally fifteen minutes, four minutes being required for mixing and eleven minutes for molding. The time required for mixing the same number with box and hoe was two minutes, and the same as in the other case for molding. I am satisfied that the mixing can be more thoroughly done in two minutes by the last-named method than in four minutes by the first. In filling the molds they were placed upon the slate slab and filled by putting in a small amount of mortar at one time, using the point of a small trowel for compacting in the molds. Mortar was put into the molds four times in filling, the last addition bringing the surface of the briquet slightly above the top of the mold, when it was troweled off perfectly true with the top of the mold. No ramming of the mortar in the molds was ever resorted to in compacting the mortar, and the briquets received all the pressure in molding from the upper side. Immediately after being molded they were placed in the damp closet for twenty-four hours, after which time they were immersed in water at 62° F., where they were kept until broken. Table 1 A, accompanying this report, shows some results obtained with Sandusky Portland cement, Medusa brand. Tables 1 B to 5 B, inclusive, show results of tests made with Lagerdorfer Portland cement and Milwaukee natural cement. Sheet 6 B is intended to show a comparison of the same barrels of cement at different ages, the barrels having been resampled after being carried over in the warehouse from the previous season. These sample tests have been selected with regard to barrel enumeration and without regard to the results obtained, so as to give a fair average of the values of results. Since July 1, 1896, the following work has been performed in cement testing:

Briquets molded	7,610
Briquets broken	7,765
Tests for fineness	102
Tests for time of setting	503
Cubes molded	49
Constant volume tests	503
Briquets on hand for future dates	1,345

Some tests have been made with the stone used in the concrete, and comparisons instituted with other local stones to show their relative value for this class of work. The stone used in the concrete is a quartzite, varying in color from light gray to dark blue. From a number of tests made with this stone, the average specific gravity was determined at 2.669, and the average weight per cubic foot at 166.213 pounds. Sandstone from local quarries showed specific gravity 2.365, and weight per cubic foot 147.831 pounds. Specimens of granite from a quarry located on the lake shore above Presque Isle Point showed specific gravity 2.670, and weight per cubic foot 166.89 pounds. An average of samples of the natural cement, as used in the monolithic work of the superstructure, showed specific gravity 2.392, and weight per cubic foot 149.50 pounds; percentage of absorption after sixteen days in water, 2.72 per cent.

Microscopical examinations have been made of sand obtained from all of the mortars used in the concrete on this work, and the fact revealed that the particles are well coated with cement in every instance.

Some interesting investigations are being made at the present time to determine the relative value for constructive purposes of a Portland cement mortar to cost the same as the mortar on natural cement, which is used on concrete construction on the superstructure. A record is kept of all tests made with cements and other materials, which would be entirely too voluminous to embody in a report, and samples of this work have been selected with a view to condensing as much as possible the information obtained.

SUPPLEMENTAL.

After the close of the working season, acting under your instructions, plans and drawings were made for the construction of foot blocks of concrete to be made during the winter season of 1896–97, and used in the construction of the concrete superstructure during the working season of 1897.

These blocks were intended to form the exposed part of the subaqueous foundation on the lake side, and are placed under the large monoliths, their outer ends resting on and flush with the face of the wall timbers of the crib on the lake side.

The primary object of this construction is to avoid the difficulty experienced in placing subaqueous concrete on the exposed lake front, the generally turbulent condition of the lake interfering very seriously with placing this concrete in such a manner as to insure good work. Figures 1 and 2, Sheet F, show a plan and elevation of these blocks with their dimensions. The grooves of trapezoidal cross section shown in the drawings (figures 1 and 2) are intended to serve two purposes, primarily, for using chains in handling the blocks, and secondarily, to be filled with cement grout after the blocks are placed for the purpose of keying them permanently. The top of the block being below the normal lake level during the working season, the grout will be introduced into the grooves by using a bag or sleeve, which, after being placed in the well formed by the grooves in two contiguous blocks, will be expanded by being filled with the cement grout, thus preventing the wash which would otherwise occur through the joints and insuring a solid key of cement. The dovetailed recess shown in the rear end of the block, fig. 2, Sheet F, is intended to unite them in a solid and permanent manner to the concrete foundation, which, as shown in fig. 3, Sheet F, is built to the same elevation as the top of the block and carried across to the harbor side. Figure 4, Sheet F, shows a perspective view of the foot blocks and foundation in place with the monoliths superimposed.

The construction of these blocks having been determined upon, during the month of November, 1896, a concrete shed 40 by 60 feet was constructed. This building was framed of very light stuff, the walls and roof were covered with 1-inch shiplapped hemlock boards, and these again covered with tarred paper held in place by 4-inch battens. The result was a building which excluded the air in a very effective manner, being easily heated by a wood-burning stove of barrel pattern 24 by 48 inches, made of No. 10 sheet steel. Water was brought into the building through a ¾-inch pipe connected with the city main and was made to flow through a coil in the stove and into barrels, which were conveniently placed for using the water in thawing out frozen material and tempering the water used in mixing the cement. A heavy floor composed of 12 by 12 inch timber from the old superstructure of the breakwater and covered with 2 by 8 inch plank dressed on one side, formed the bottom for the concrete molds. Four molds were made, consisting each of four pieces framed of 6 by 6 inch and 4 by 4 inch pine and lined with 2 by 8 inch plank dressed on one side. Two strips of trapezoidal cross section were laid on the floor inside the molds, and four more of the same description were lightly nailed to the sides of the mold for forming the grooves, as shown in figures 1 and 2, Sheet F.

The core used for forming the dovetail in the end of the blocks was made in three wedge-shaped pieces, the central wedge having its base against the inside of the end piece of the mold and the two outside wedges with their bases in the opposite direction. When the form was removed the central wedge was easily knocked out, allowing the other two sections of the core to come away easily. By means of a small block lightly nailed to the base of the core a recess was molded at the base of the dovetail to provide for lifting the blocks with a hydraulic jack when the time arrived for moving them from the floor. The top of the mold consisted of 8 by 8 inch plank nailed to heavy battens of 6 by 6 inch pine, and when the mold was filled with concrete well compacted with 36-pound iron rammers, in such a manner that the concrete was a little more than flush with the top of the mold, the heavy top piece was laid on and well rammed down, giving a perfectly true face to the top of the block.

The materials used in the construction of these blocks consisted of Portland cement (Lagerdorfer, Eiffel Tower brand), stone screenings which would pass a ¼-inch sieve, and lake sand passing No. 10 sieve. The stone screenings were used because they could be purchased at a lower price than the broken stone or larger size. The screenings weighed 92 pounds per cubic foot and contained 45.11 per cent of voids.

The sand was lake shore sand and contained 32 per cent of voids, 100 per cent passing No. 10 sieve, 93.70 per cent passing No. 20 sieve, 52.55 per cent passing No. 30 sieve, and 11.30 per cent passing No. 50 sieve.

The stone screenings showed 24.18 per cent passing No. 10 sieve. From these characteristics of the stone and sand, coupled with the use for which this concrete is intended, the proportions of materials to be used in one cubic yard of concrete were determined to be—

	Quantity.	Weight.
	Cubic feet.	*Pounds.*
Stone screenings	27	2,484
Sand	12.18	1,218
Portland cement	6.35	540
	45.53	....

Then the contraction in mixing will be represented by 45.53—27=18.53, or 40.69 per cent.

With the sand and stone perfectly dry, the theoretical amount of water as determined was 8 per cent for the sand and 21 per cent for the cement, but as a matter of fact, both sand and screenings having been saturated by the autumn rains and then frozen hard, rendered the use of any formula in this respect useless. In a few cases ideal mixtures of concrete were made without the addition of any water whatever.

The proportion of cement to the dry ingredients in this concrete is 1 to 6.855 by weight and 1 to 6.167 by bulk.

The cost of material per cubic yard is as follows:

27 cubic feet stone screenings, at $1.10 per cubic yard	$1.10
12.18 cubic feet sand, at 45 cents per cubic yard	.203
540 pounds Portland cement, at $2.75 per barrel	3.91
	5.213

The cost of labor and material from actual time and quantities is as follows for making 40 blocks:

Superintendence	$42.66	
Labor, 1,000 hours, at $0.125 per hour	125.00	
Watchman	29.15	
Labor, cutting and hauling wood	23.80	
		$220.61
126 barrels Portland cement, at $2.75	346.50	
88.9 cubic yards screenings, at $1.10	97.79	
40.1 cubic yards sand, at 45 cents	18.04	
5 gallons oil, at 65 cents	3.25	
		465.58
		686.19

Cost per cubic yard as demonstrated by the foregoing statement, $686.19 ÷ 88.9 = $7.718.

If to this be added 10 per cent of the following items of cost, we will have—

Labor and material constructing concrete shed	$243.70
Labor on floor for concrete molds	54.25
Material for covering floor	37.33
Labor on four molds for foot blocks	82.95
Material used for molds	42.33
	*460.56

Total cost per cubic yard, $46.06 + 686.19 ÷ 88.9 = $8.236.

The work of molding was commenced on December 24, 1896, and continued without intermission on working days until January 27, 1897, inclusive; in which time 28 of the blocks were completed. From January 27 to February 11, 1897, inclusive, a storage track, turntable, gallows frame, a heavy four-roller truck, and a windlass were constructed. Within the same period 10 blocks were removed from the concrete shed and placed on the storage track, to give necessary space in the shed for additional blocks. The work of molding was resumed on February 12 and continued until February 26, inclusive, in which time 12 blocks were completed, making a total of 40 blocks. Three laborers performed all of the labor in making these blocks, and a part of the time of the overseer and watchman is charged to the cost. A half day was generally required to mix and mold one block, the remainder being devoted to removing and setting the forms and keeping up the supply of material. Of course all material from the bins was at all times in a frozen condition and had to be thawed out with hot water before mixing. Hence it was important to keep a supply sufficient for a few days' work in the shed to give necessary time for expelling the frost. The interior of the concrete shed was very evenly maintained at a temperature ranging from 50° to 65° F. It was a part of the duty of the watchman to keep the fire at night, and he also elevated a block each night with hydraulic jack to the required elevation for placing the block truck in position when the time arrived for moving it. Samples of concrete were obtained from the mixture for each block, and 9 briquets were made from each sample, to be broken in sets of three at seven days, twenty-eight days, and six months, respectively. One hundred and twenty briquets broken at seven days showed a mean tensile strength per square inch of 153.8 pounds, and 120 briquets broken at twenty-eight days showed a mean tensile strength of 234.9 pounds. From each sample a 6-inch cube of concrete was also molded to be used for future tests.

The specific gravity of this concrete as molded is 2.431, and weight per cubic foot 150.81 pounds. The average of 40 tests made to determine the percentage of absorption gives a result of 2.443 per cent.

The blocks which were removed from the concrete shed in the month of February were all upward of 28 days old at the time of removal. The outside temperature during the month of February ranged from —8° to +40° F. From many tests made with samples of this concrete it is believed that no permanent change of volume will occur from freezing temperatures after it is 7 days old. At the date of this writing 28 of the blocks have been placed in position in the work. All of the mechanical devices designed and built for handling, transporting, and setting them have worked very successfully. The preparation of the crib for their reception is shown in fig. 3, Sheet F. Great care is exercised in forming a level floor of stone under the blocks so as to insure a solid bearing on the stone in the cribs as well as the wall timber on the front and the timber placed on the rear end of the block. This work has not presented as much difficulty as was anticipated, but the very cold and backward season with the accompaniment of much rough water rendered the progress of setting the blocks slower than it would have been with reasonably good weather. The experience acquired in setting these blocks suggests the expediency of performing all of this work along with the subaqueous foundation in one season, and constructing the large monoliths during the succeeding season. By this method the best conditions of weather and water might be obtained and the work greatly expedited thereby. The work of setting the blocks referred to as being in place as well as preparing the foundation for them was performed between May 27 and June 15 as the weather would permit, and the temperature of the lake water was from 38° to 40° F., with temperature of air from 34° to 55° F.

It will be readily understood that such conditions are very unfavorable to submarine work on account of the hardship to men engaged in it.

Plate No. 62 shows the interior of the concrete shed as it appeared during the winter season, while the work of molding was in progress. Plate No. 56 illustrates

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* This expenditure is common to the whole block structure, and as there are 388 more blocks to be made, the cost per cubic yard will be materially reduced.—C. B. S.

Superstructure to Breakwater

quette Michigan.

PLAN OF

RUCTURE TO BREAKWATER

SECT COMPLETED

MBER 16th 1896.

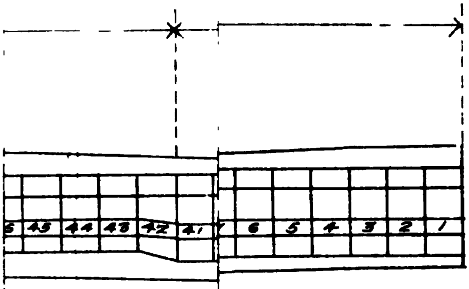
n of Major Clinton B. Sears,

by Clarence Coleman.

ant Engineer.

ior

SCALE: 1 In. = 50 Ft.



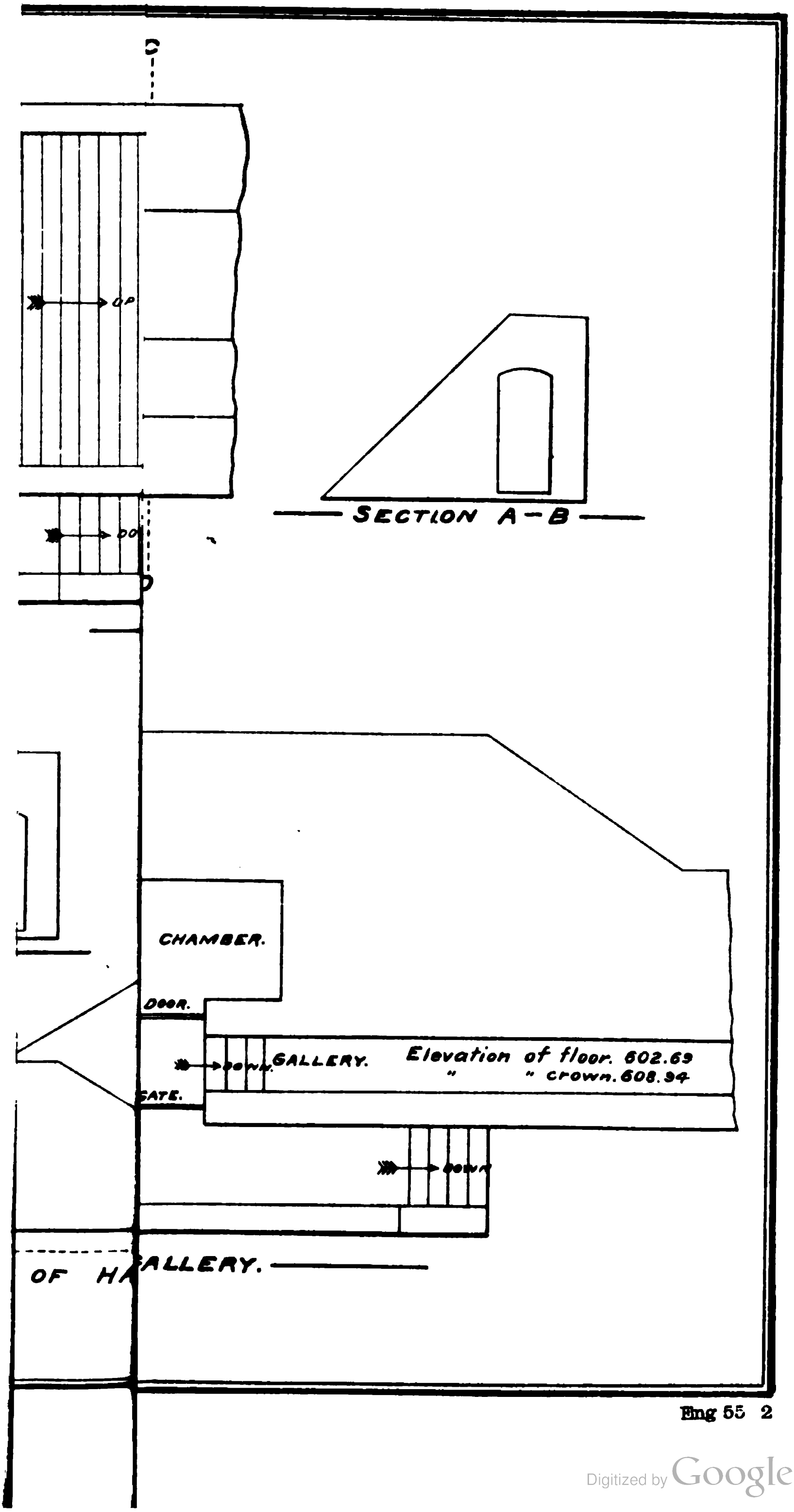
south End of Concrete

Har

TO ACC

47 inclusive, completed in 1895

36 " " " 1896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UP
DO
D
SECTION A-B
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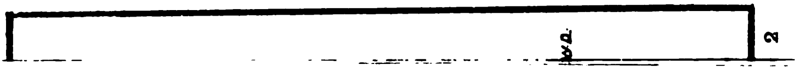
DOOR.
GALLERY.
DOWN.
Elevation of floor. 602.69
" " crown. 608.94
GATE.
DOWN
OF H…ALLERY.

Eng 55 2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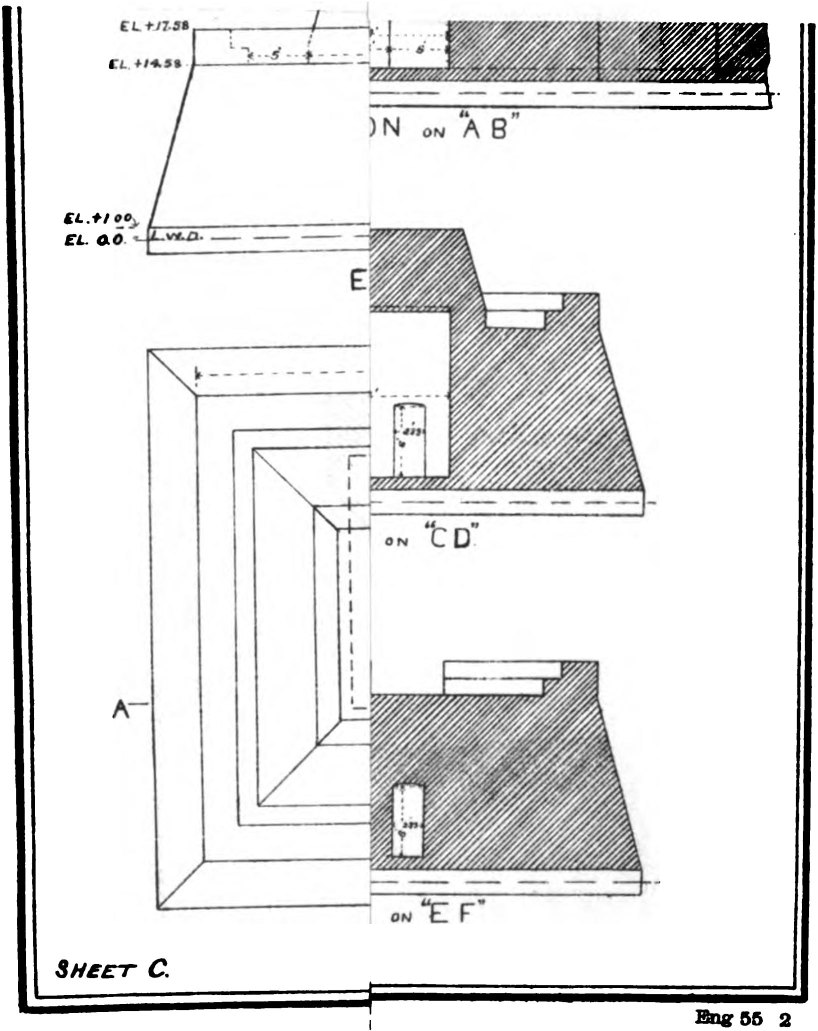
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SHEET C.

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SHEET E.

TO ACCOMPANY MY ANNUAL REPORT, OF JUNE 30TH, 1897.
Clinton B. Sears.
MAJOR, CORPS OF ENGINEERS, U.S.A.

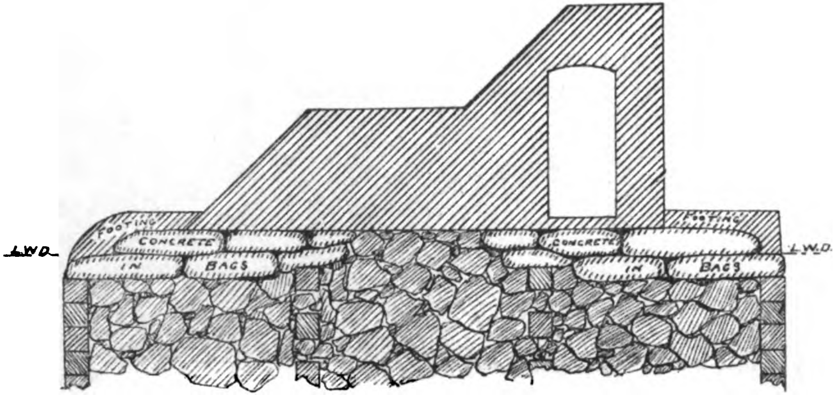
MARQUETTE
HARBOR IMPROVEMENT

CONSTRUCTION OF CONCRETE SUPERSTRUCTURE
TO BREAKWATER

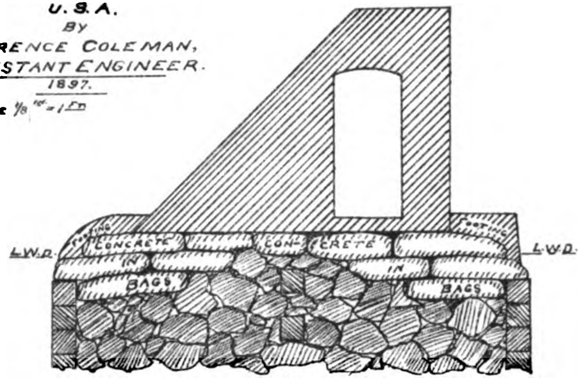
CROSS SECTIONS OF BREAKWATER SHOWING METHOD OF PREPARING FOUNDATION DURING SEASON OF 1896.

MADE UNDER THE DIRECTION OF.
MAJOR CLINTON B. SEARS.
CORPS OF ENGINEERS.
U.S.A.
BY
CLARENCE COLEMAN,
ASSISTANT ENGINEER.
1897.

SCALE 1/8 in = 1 Ft



TYPICAL SECTION OF BLOCK OF REDUCED SECTION
ON 30 FT. CRIB.



TYPICAL SECTION OF BLOCK OF MINIMUM
SECTION ON 20 FT. CRIB AT SHORE END.

SH

PLATE 28.

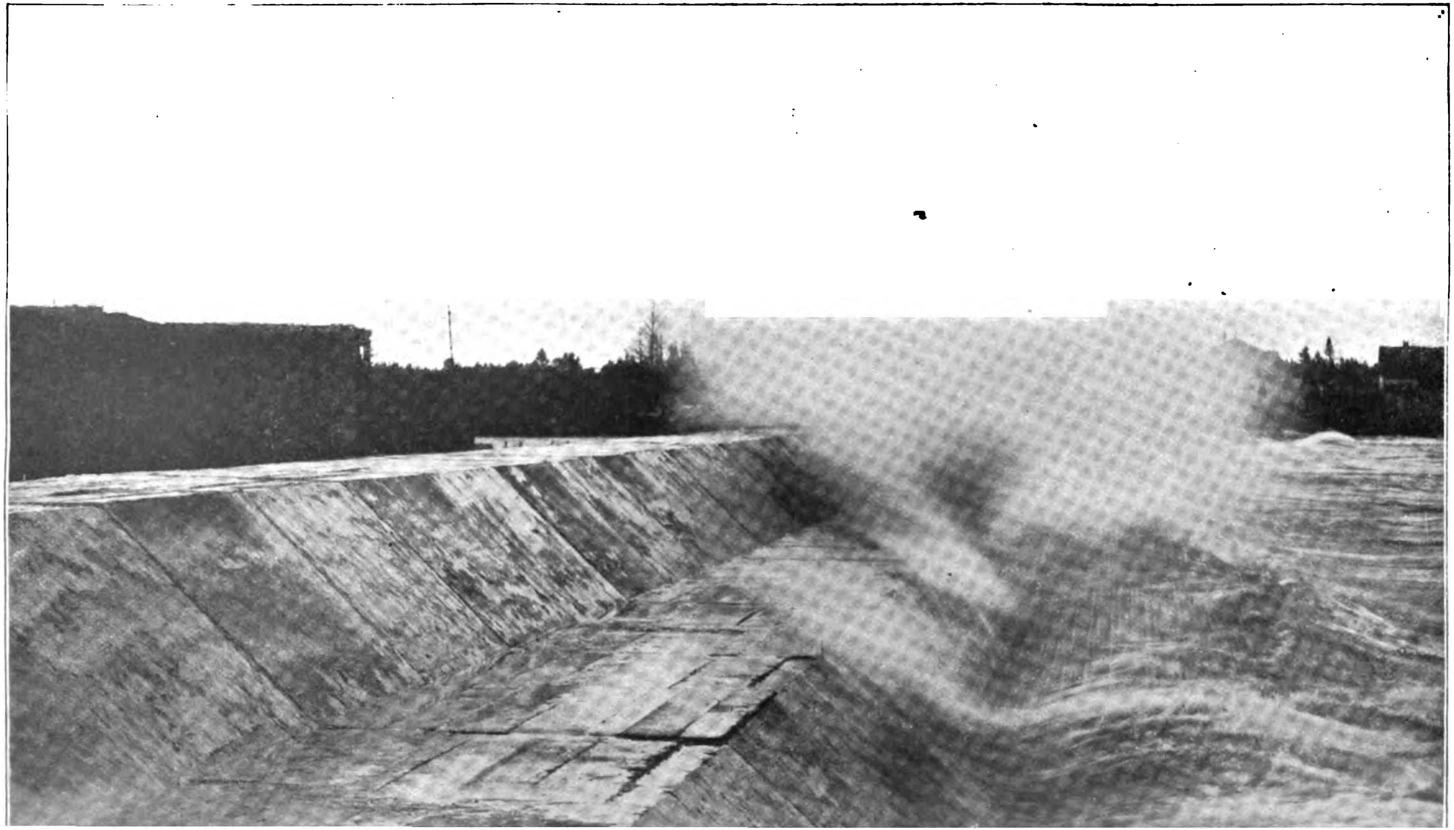
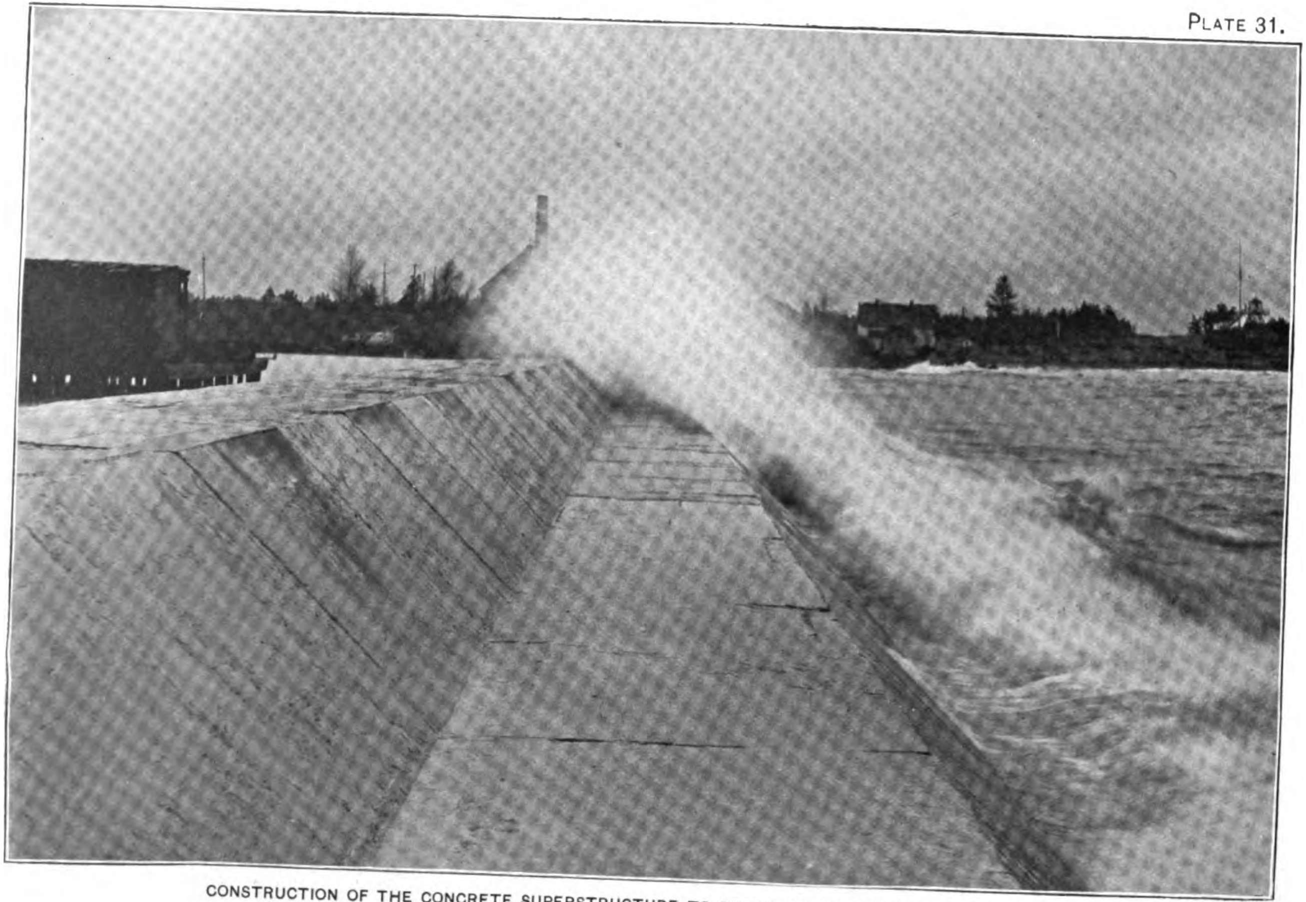


PLATE 31.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, **MARQUETTE, MICHIGAN.**

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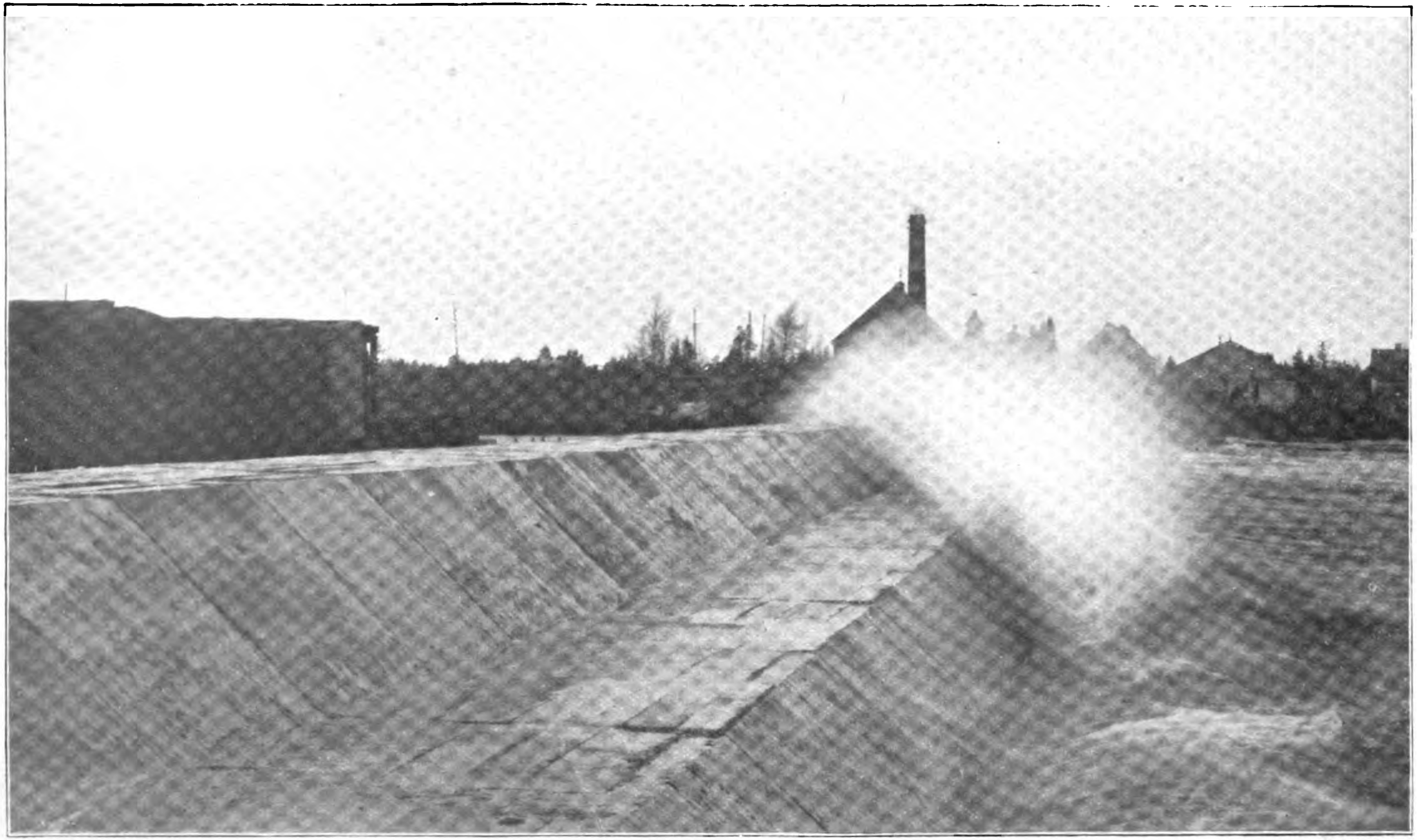
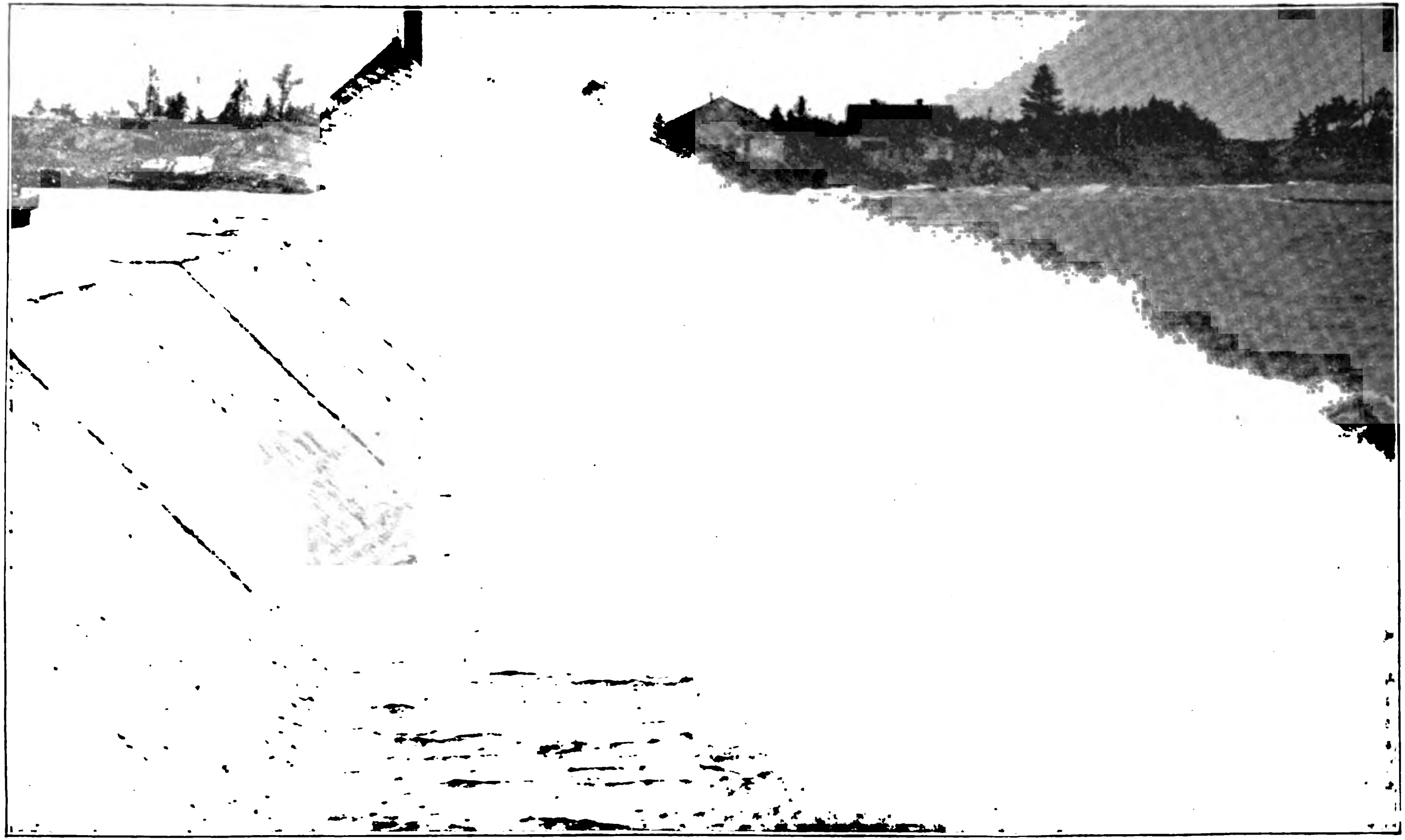


CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

8

PLATE 34.

PLATE 35.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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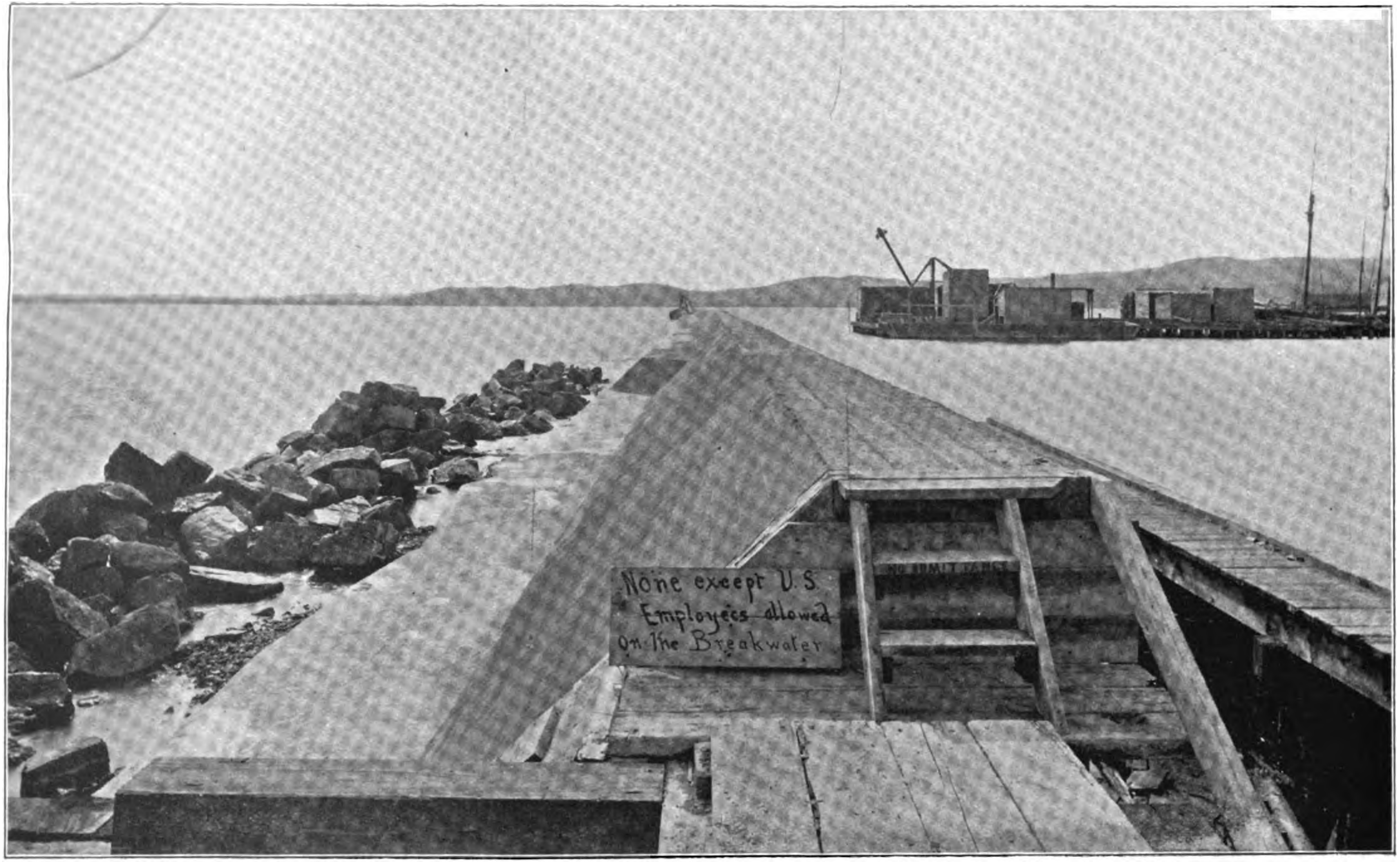
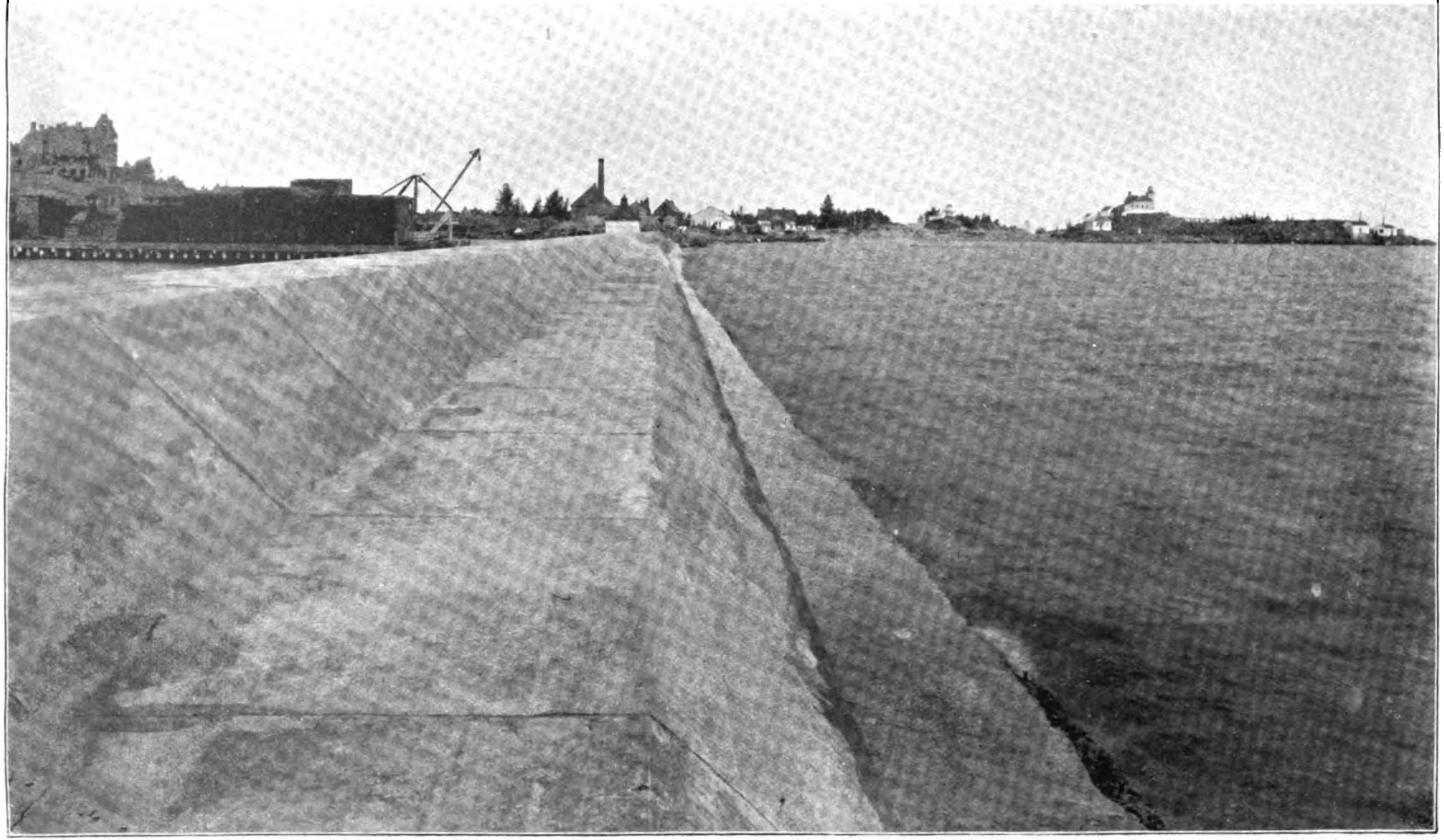
PLATE 39.

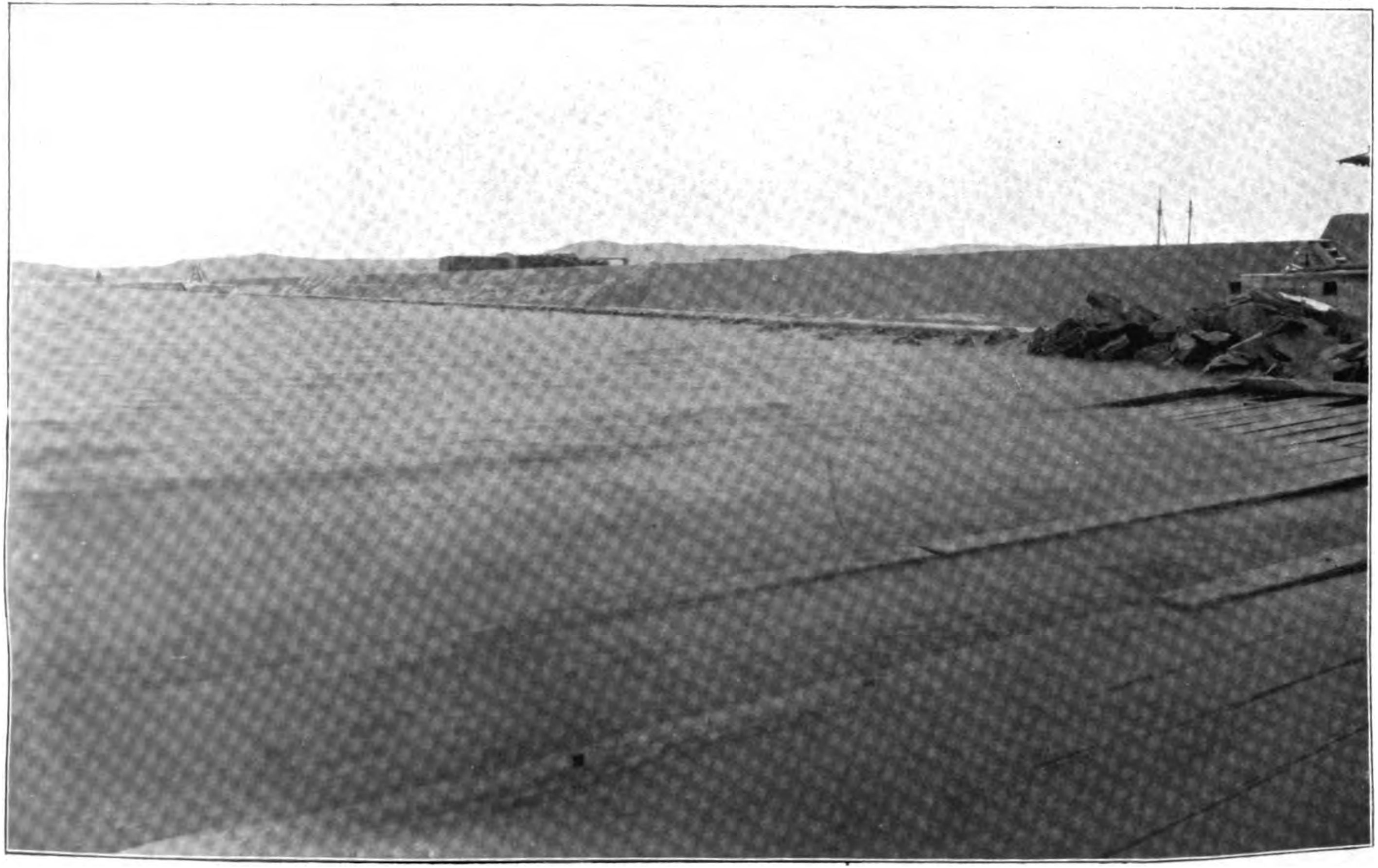


CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 41.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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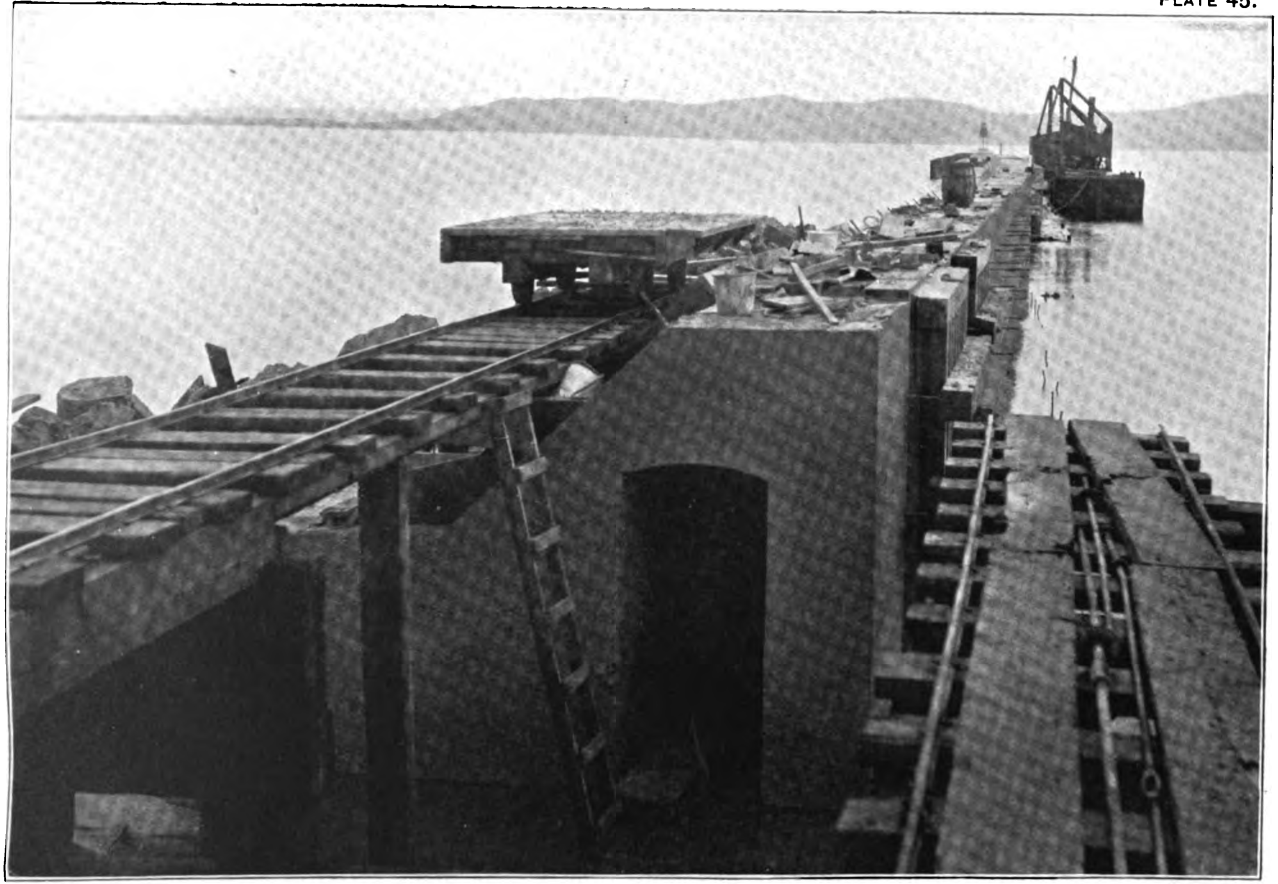
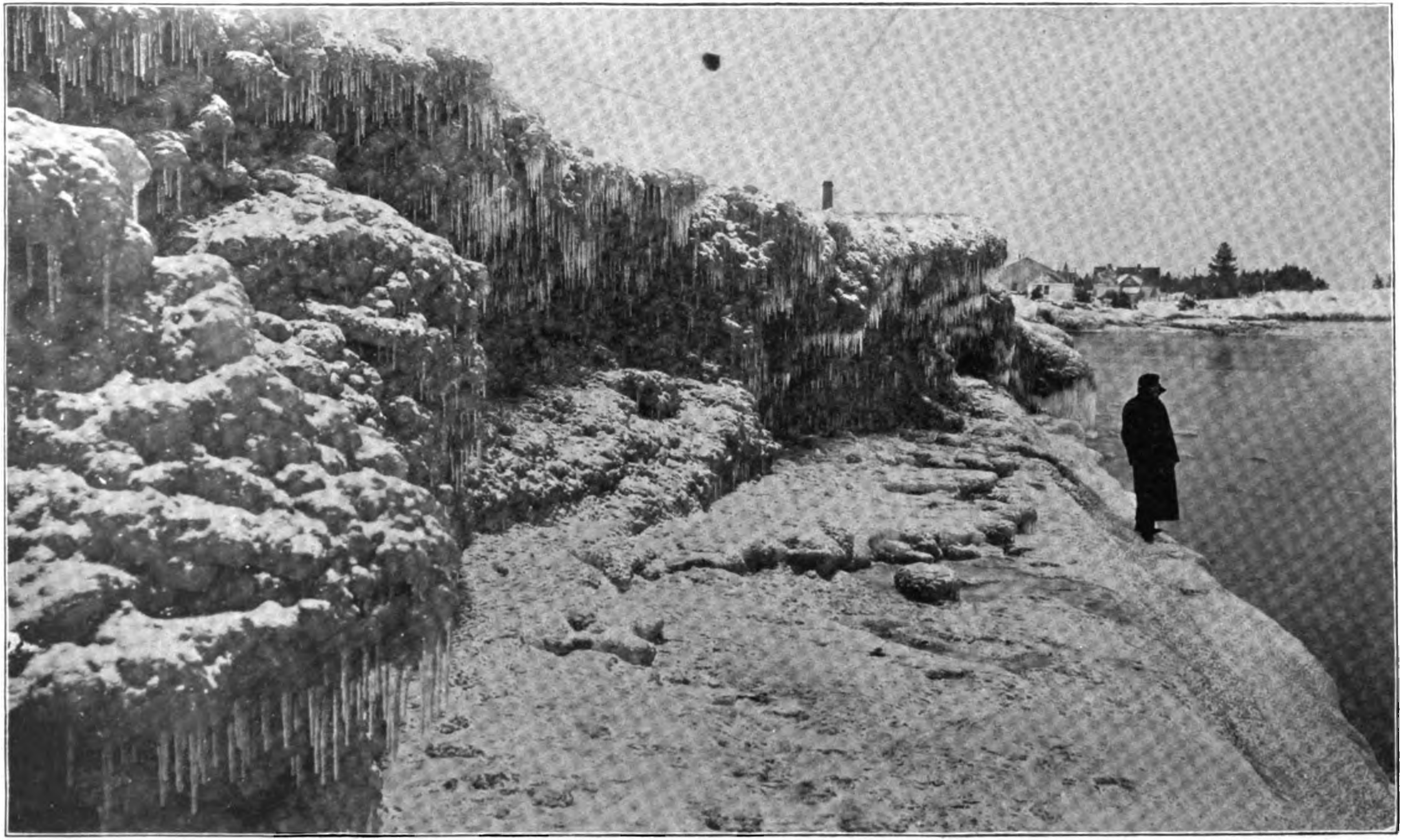
PLATE 45.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 55.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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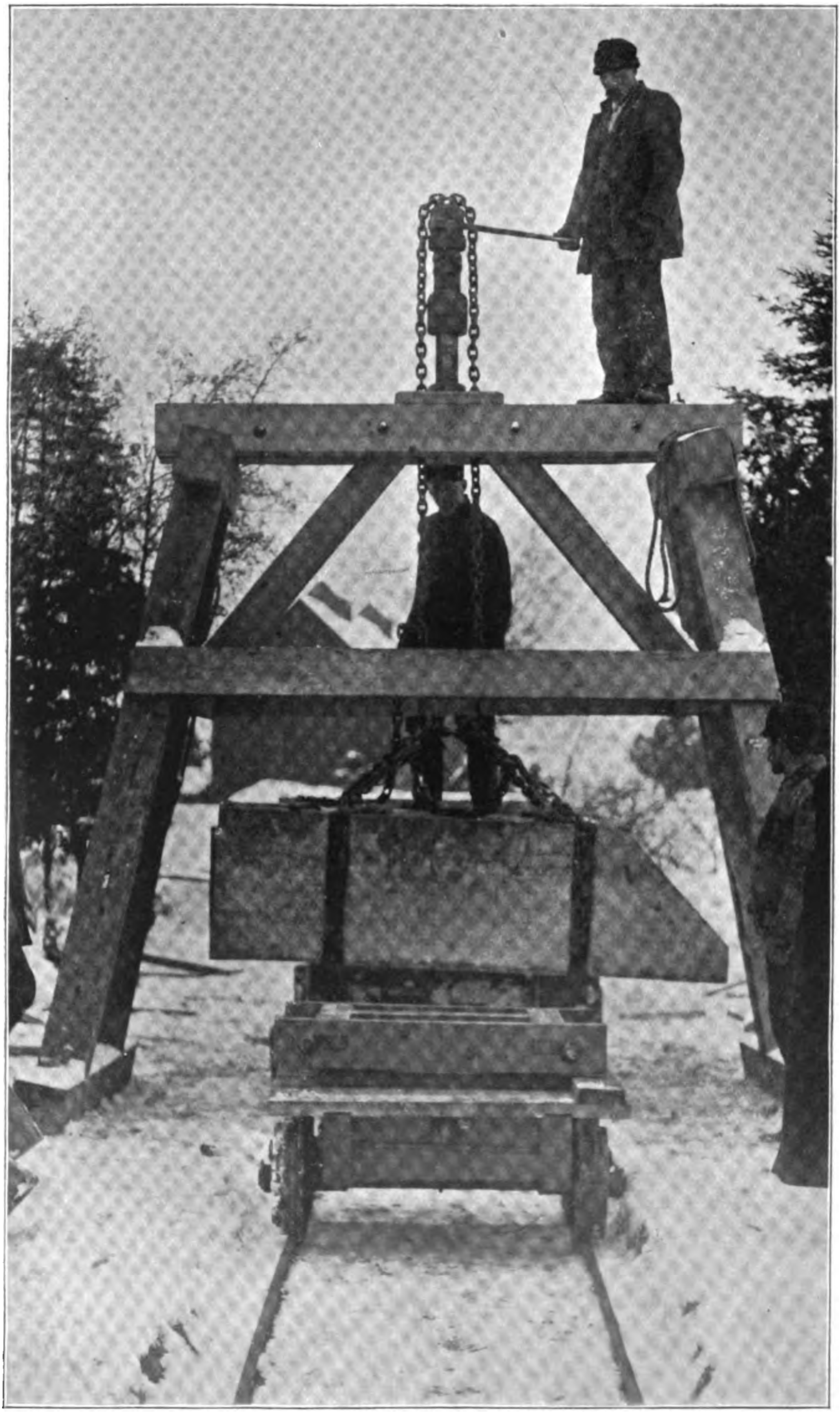


CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 59.

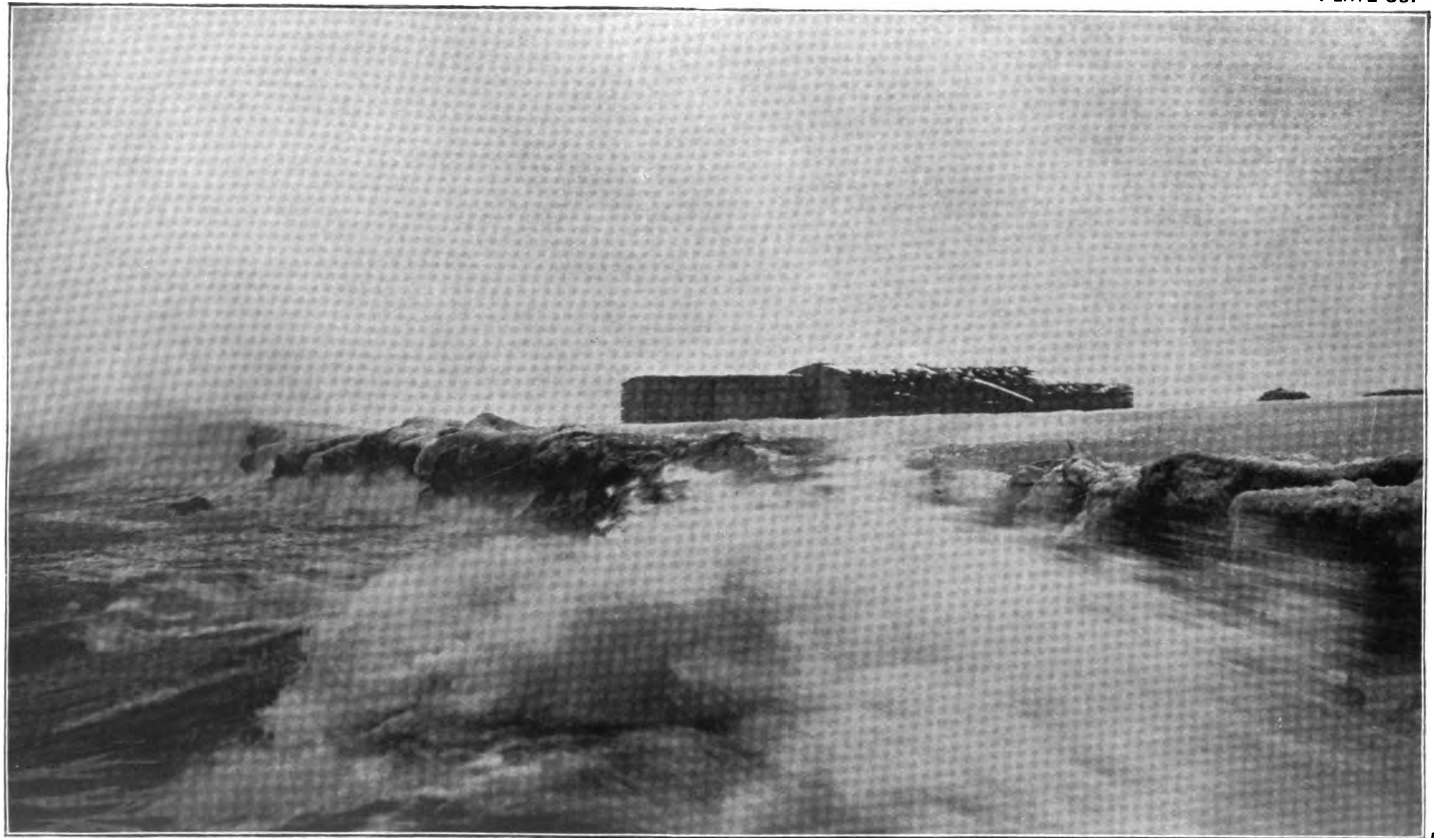
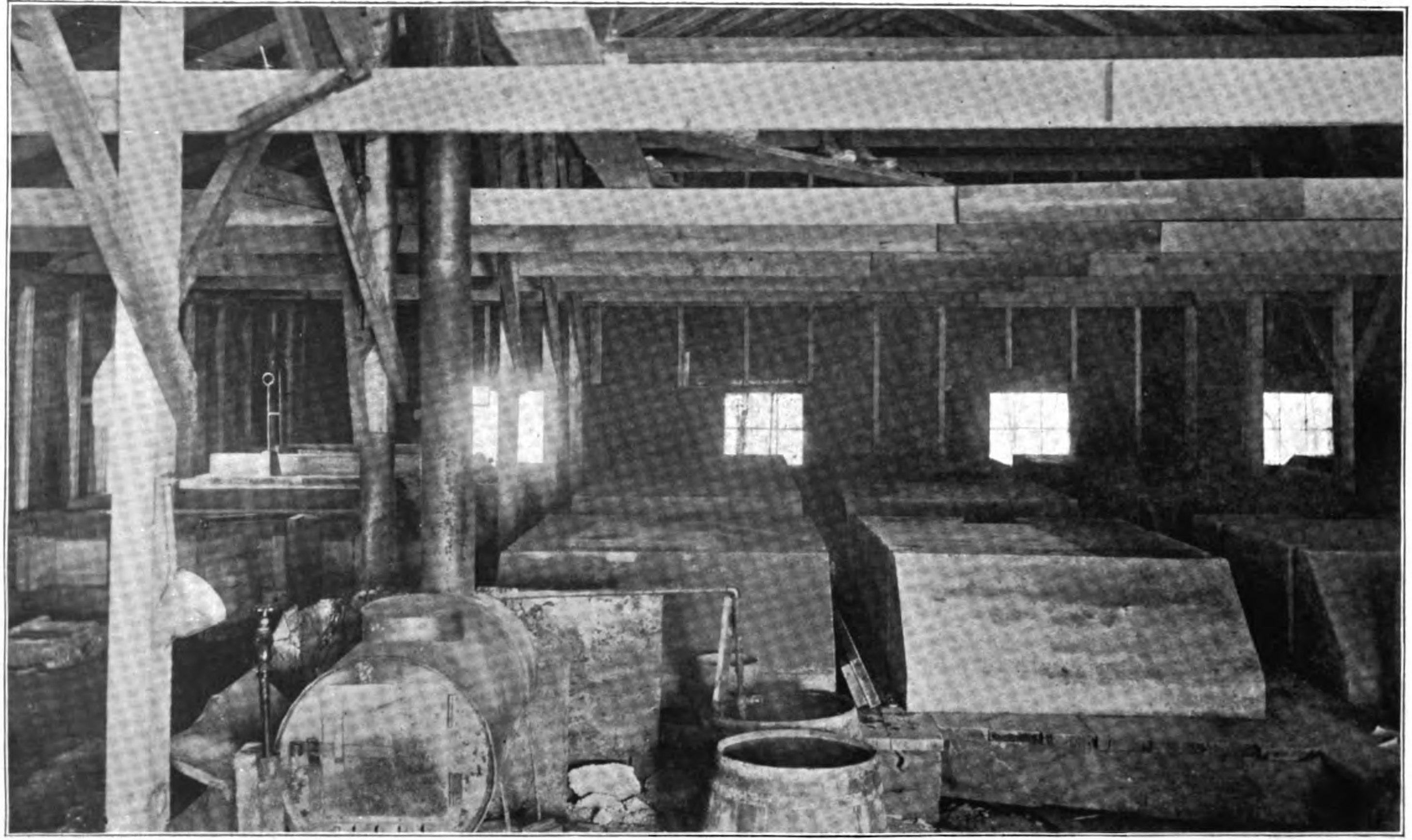


PLATE 62.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

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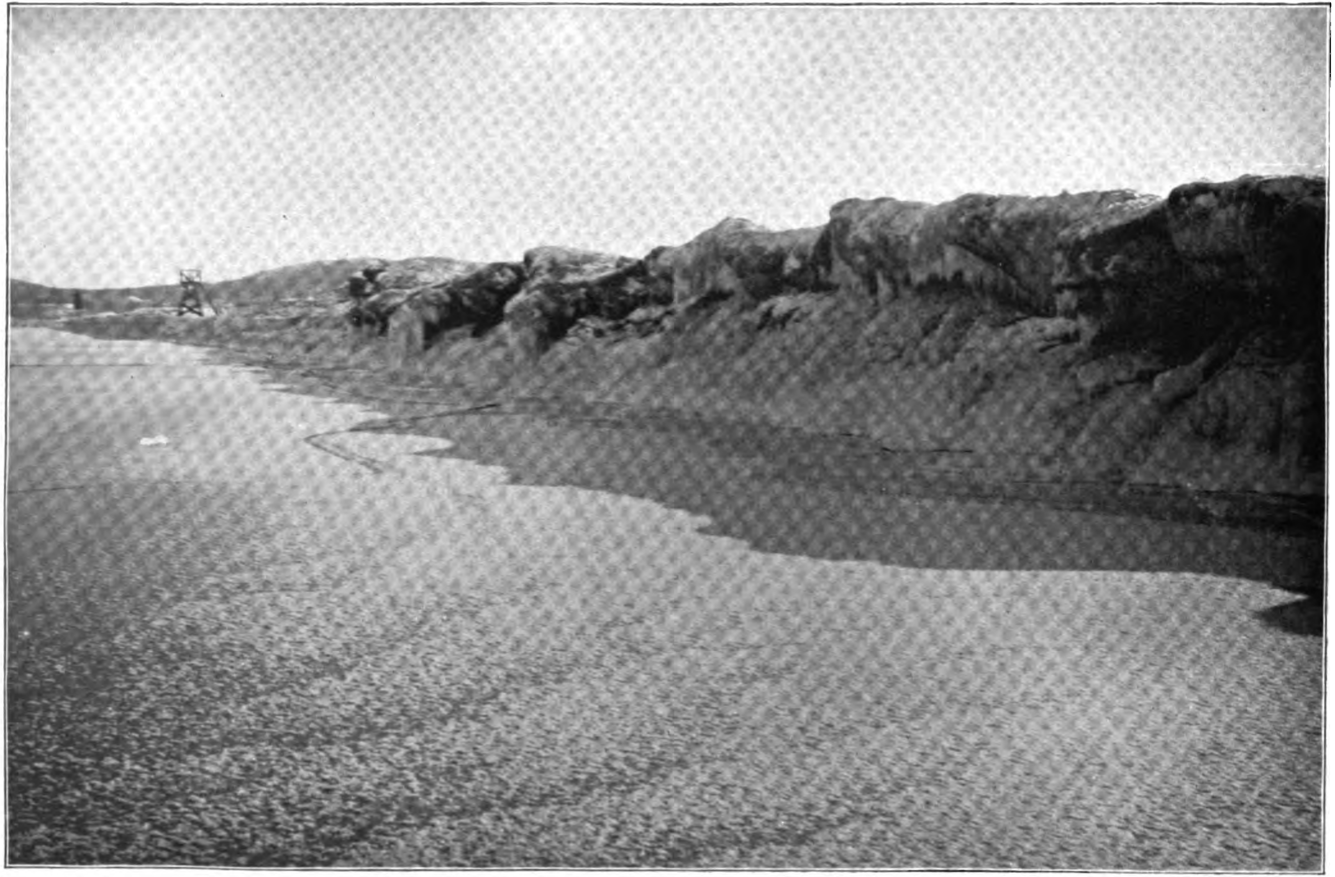
PLATE 70.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

Plate 71.

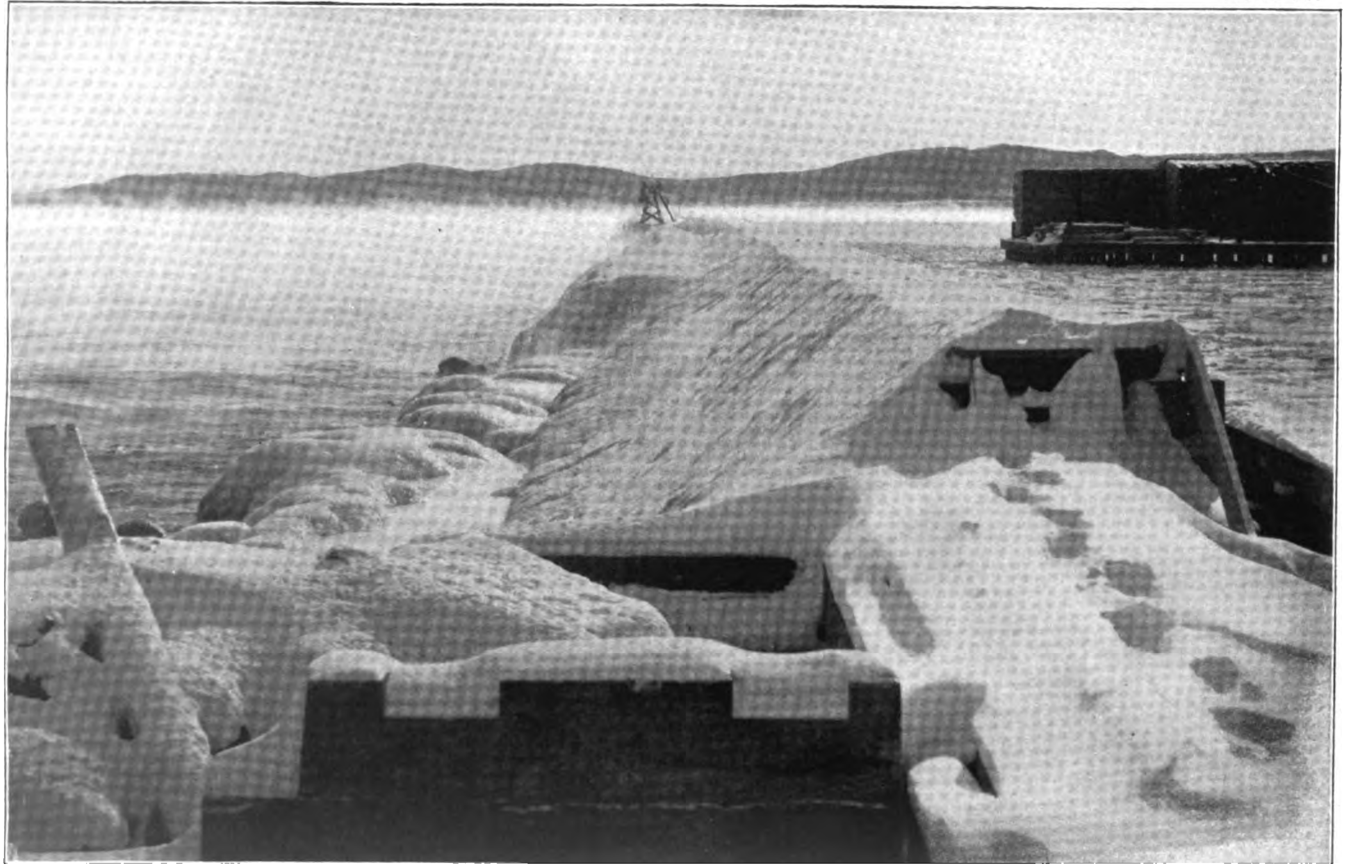


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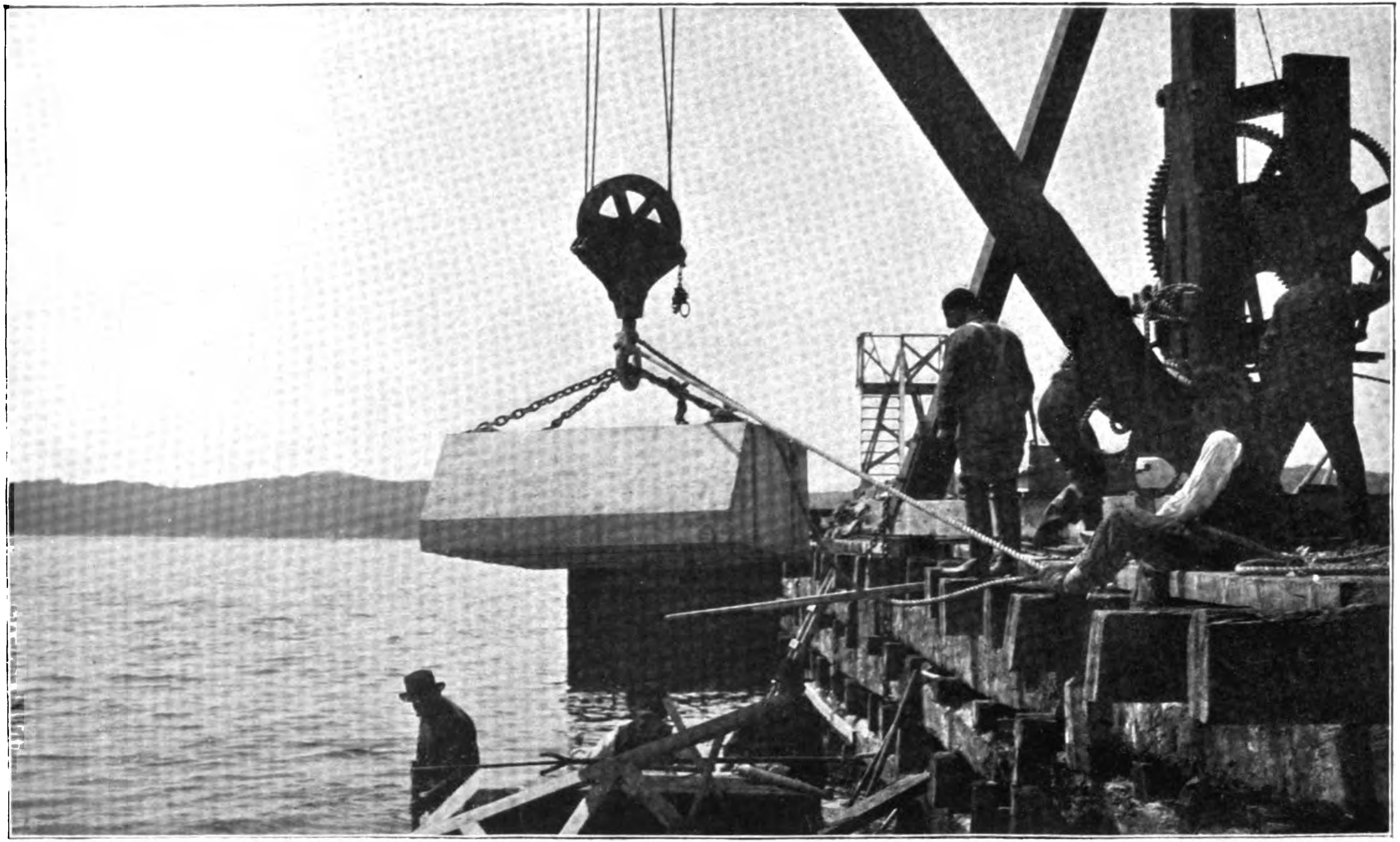
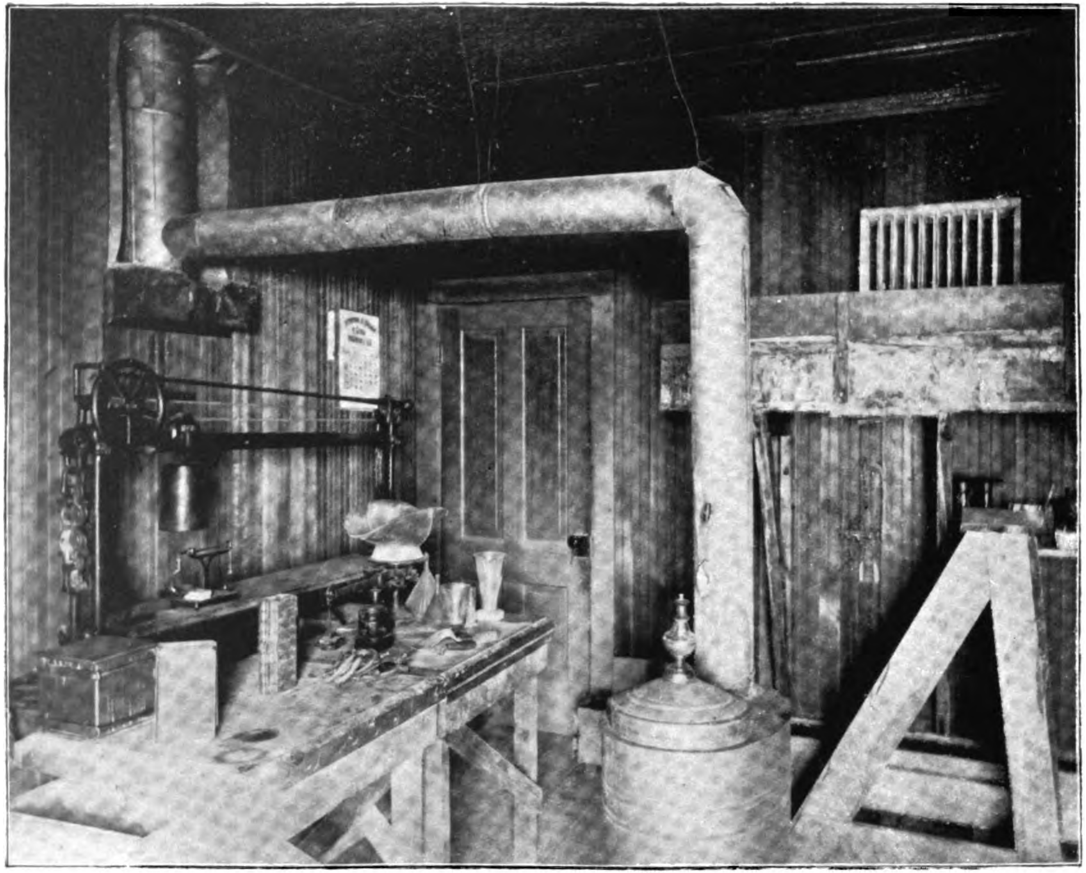
PLATE 75.



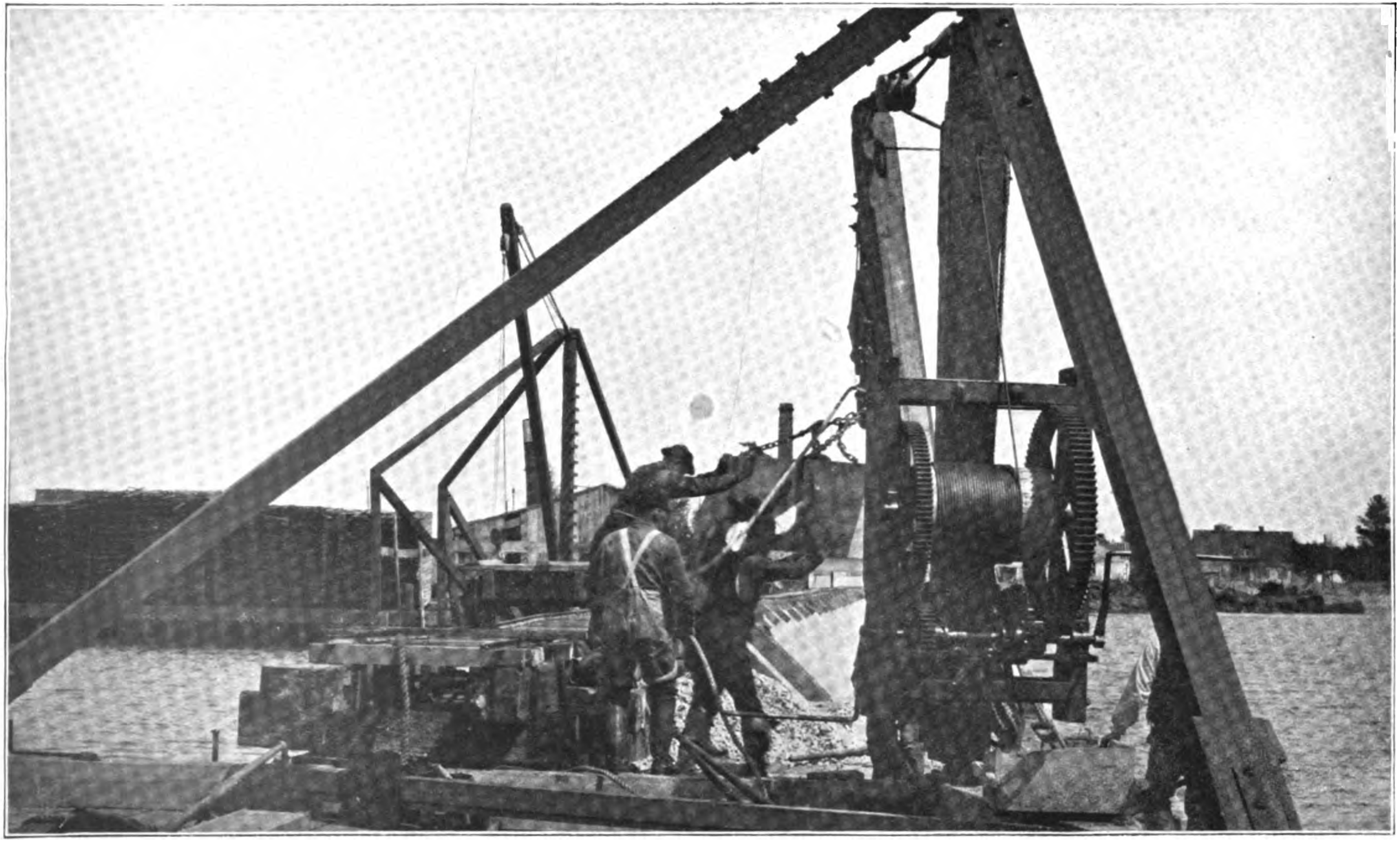
CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 76.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 77.



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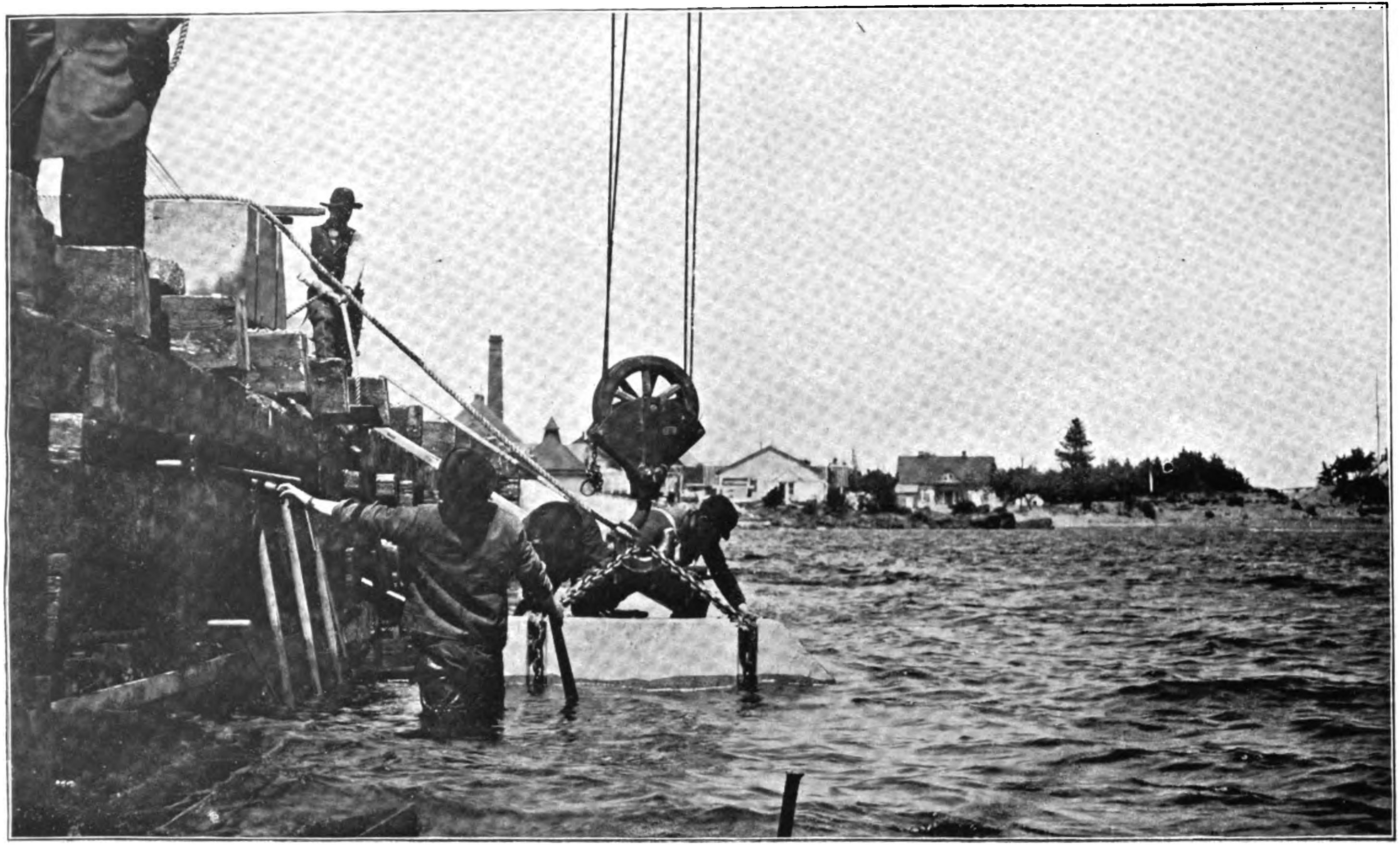


CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

PLATE 79.

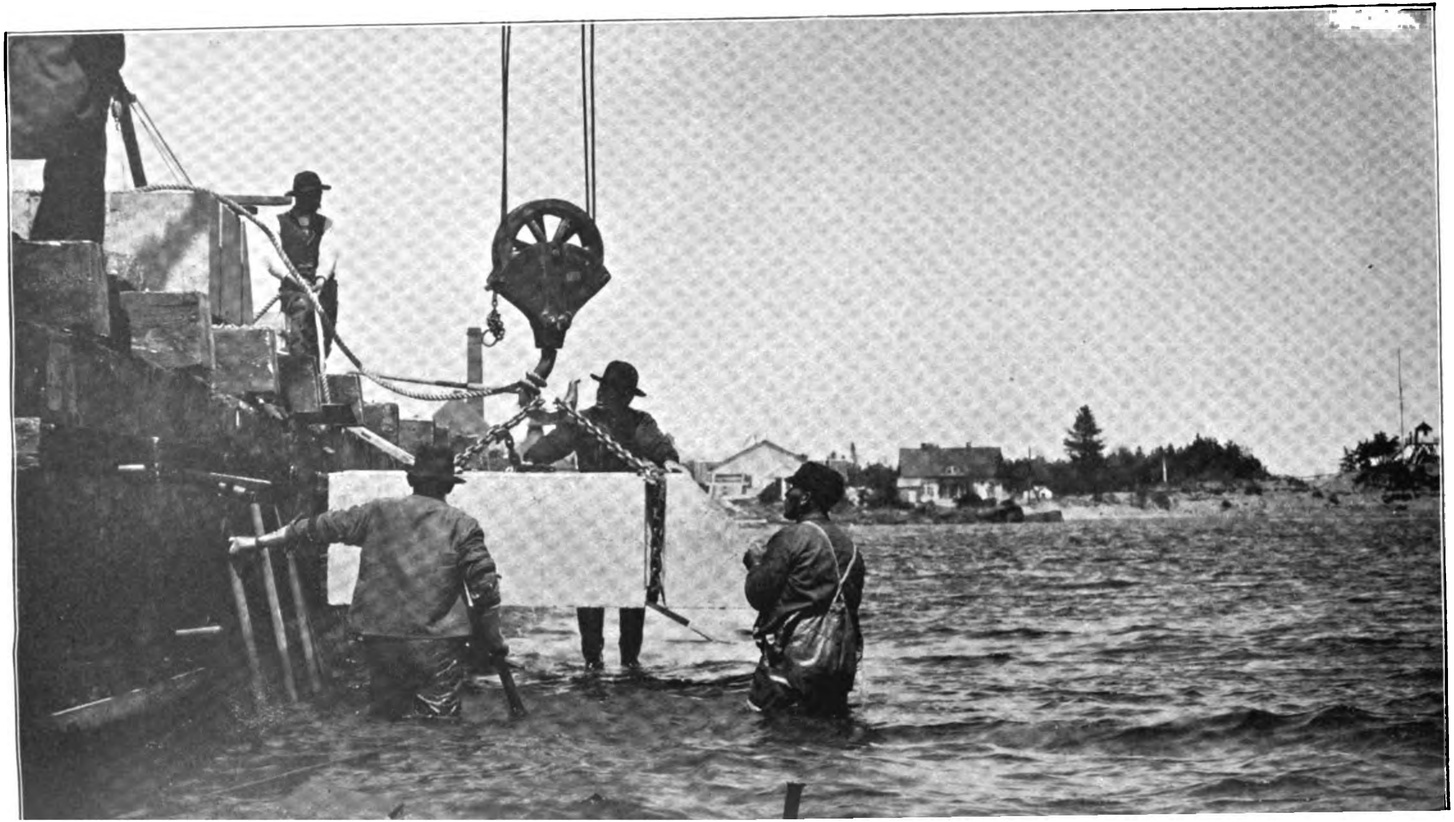


PLATE 80.

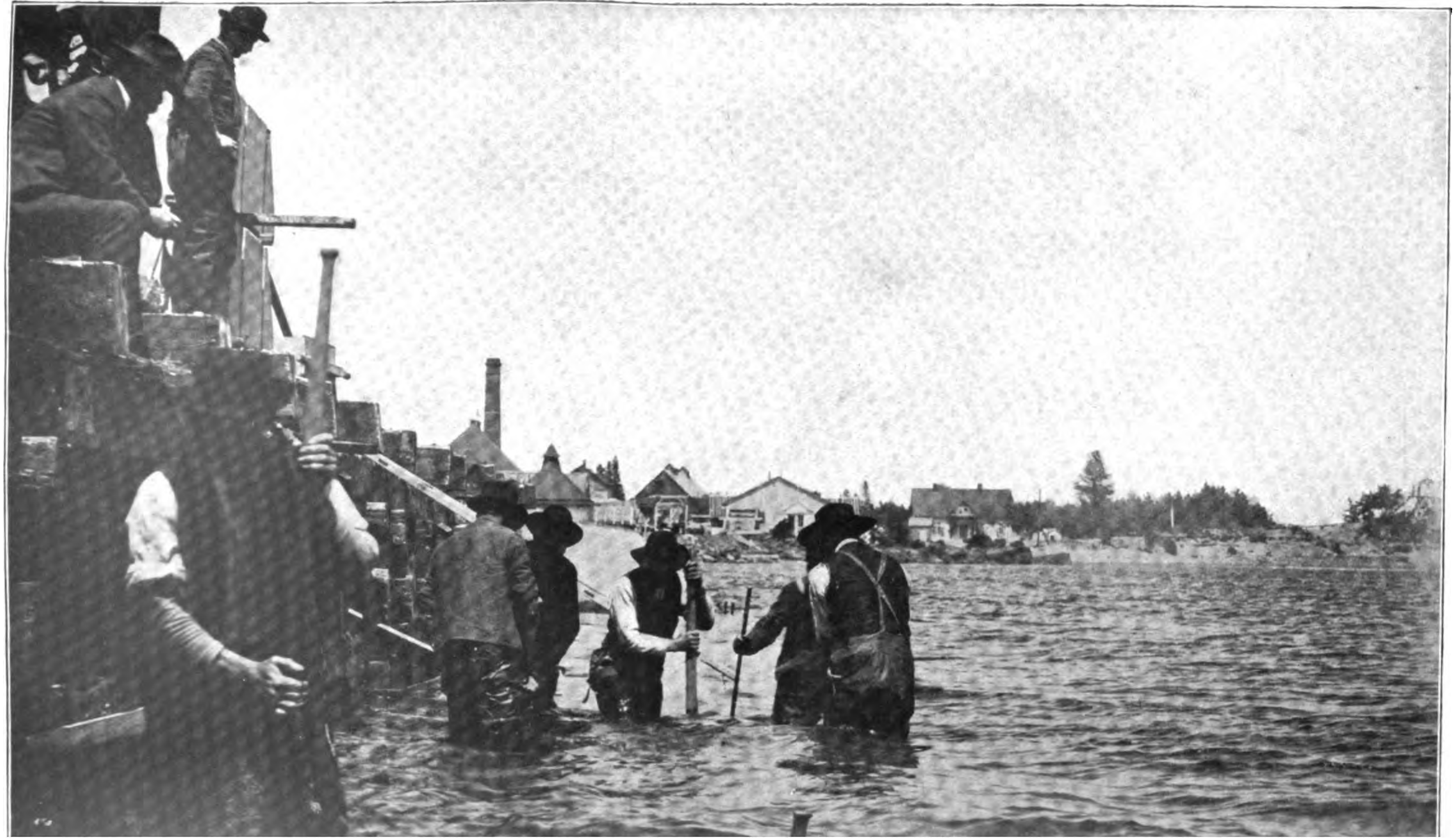
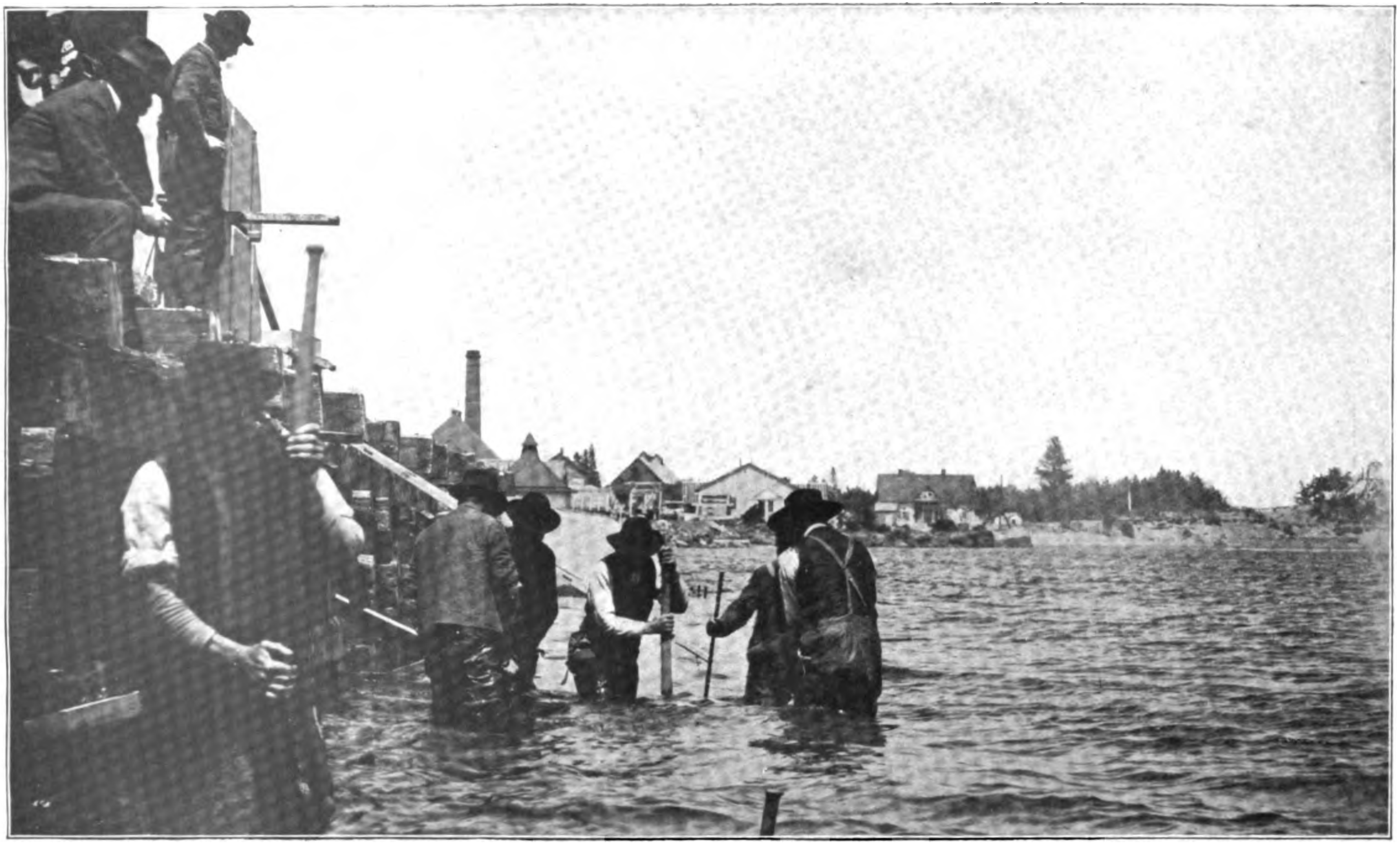
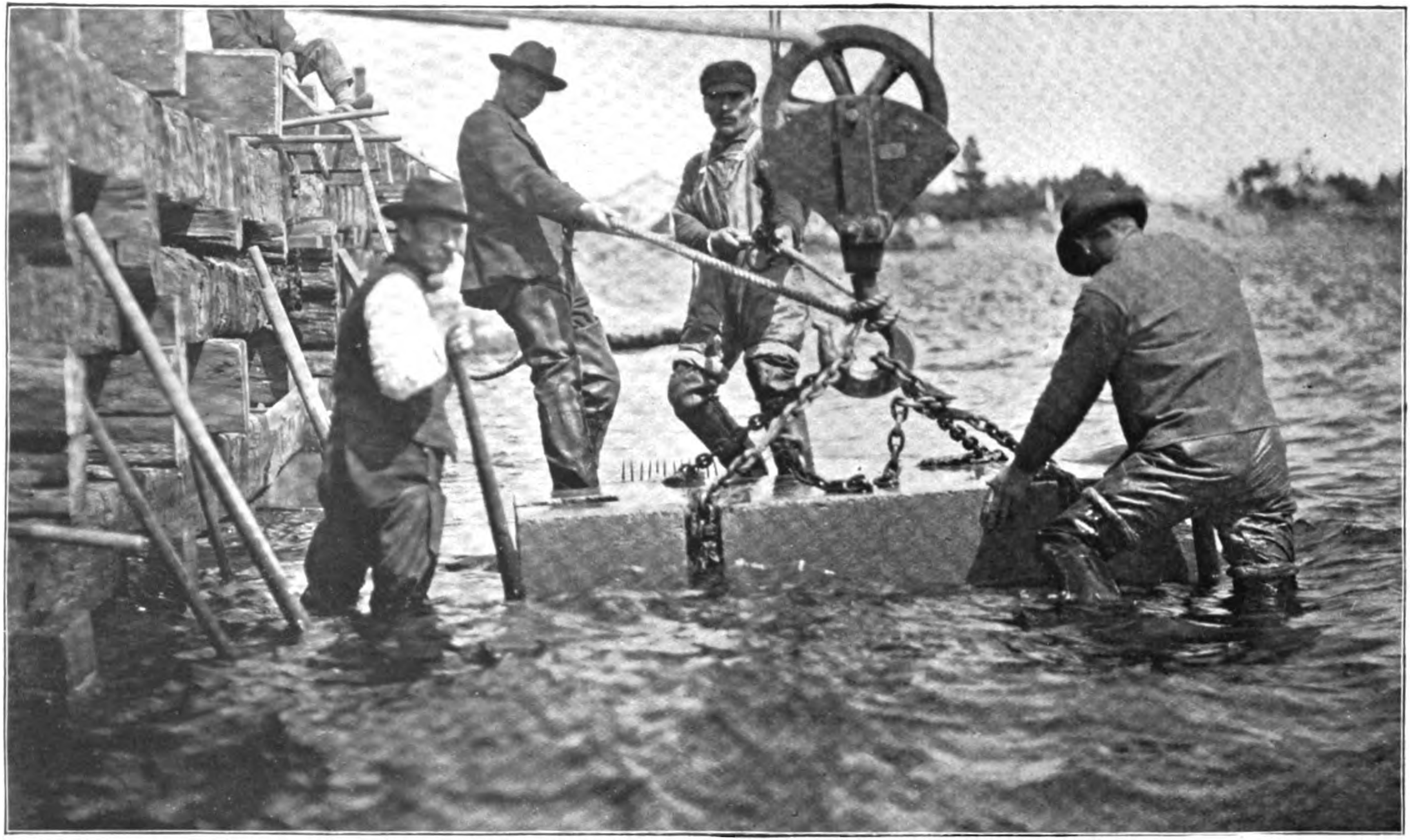


PLATE 80.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.



CONSTRUCTION OF THE CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICHIGAN.

the method of removing the truck from under the blocks by means of the gallows frame and hydraulic jack. The blocks are transported out to the work on cars over a 36-inch gauge track laid on the parapet of the concrete superstructure and then set in place by a portable derrick of 15 tons capacity. This derrick is also utilized for pulling drift bolts in preparing the foundation. Plate No. 80 shows the men at work preparing the foundation for the blocks. As shown in that view, a part of the superstructure of timber and stone has been removed from the lake front back to the first row of longitudinal ties and to a depth of 1 foot below the low-water datum, which means about 2 feet below the normal lake level in the working season. That portion of the superstructure which has not been removed serves as a platform from which the derrick can be operated. Plates Nos. 75, 77, 78, 79, and 82 show different movements in the operation of setting the blocks in place. Notes on Sheet F give the cubical volume, weight, etc., of the blocks.

The concrete composing the blocks resembles granite in appearance and is sufficiently hard to resist wear and abrasion from the chains in handling. It is believed that this method of construction will prove efficacious and satisfactory, especially if the summer weather can be utilized for block setting.

All of the work in connection with the construction of the concrete superstructure to the breakwater has been performed by hired labor. No accidents involving any serious injury to employees or loss of property have occurred, and no violations of the laws of the United States pertaining to navigable waters have been observed, other than some of a minor character, which have already been reported.

Very respectfully, your obedient servant,

CLARENCE COLEMAN,
Assistant Engineer.

Maj. CLINTON B. SEARS,
Corps of Engineers, U. S. A.

Concrete superstructure to breakwater at Marquette, Mich.

CEMENT TESTING, 1895.—CHARACTERISTICS OF CEMENT AND SAND.

No. of barrel.	Cement.				Sand.				
	Kind.	Time of setting, to bear $\frac{1}{16}$-inch wire weighing 1 pound.	Fineness.		Kind.	Fineness.			
			Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.		Per cent passing No. 10 sieve.	Per cent passing No. 20 sieve.	Per cent passing No. 30 sieve.	Per cent passing No. 50 sieve.
	First shipment.	*Minutes.*							
55	Portland	85	98.69	90	Lake	100	92.65	57.36	10.37
105	do	105	98.69	90	do	100	92.65	57.36	10.37
155	do	180	98.69	90	do	100	92.65	57.36	10.37
205	do	195	98.69	90	do	100	92.65	57.36	10.37
255	do	135	98.40	88.80	do	100	92.65	57.36	10.37
305	do	150	98.86	91.79	do	100	92.65	57.36	10.37
355	do	72	96.63	89.50	do	100	92.65	57.36	10.37
	Second shipment.								
50	Portland	145	98.69	90	Lake	100	92.65	57.36	10.37
100	do	120	98.69	90	do	100	92.65	57.36	10.37
150	do	145	98.69	90	do	100	92.65	57.36	10.37
200	do	150	98.69	90	do	100	92.65	57.36	10.37
250	do		98.69	90	do	100	92.65	57.36	10.37
300	do	180	98.69	90	do	100	92.65	57.36	10.37
350	do	150	98.69	90	do	100	92.65	57.36	10.37
400	do		98.69	90	do	100	92.65	57.36	10.37
450	do		98.69	90	do	100	92.65	57.36	10.37
500	do		98.69	90	do	100	92.65	57.36	10.37
550	do		98.69	90	do	100	92.65	57.36	10.37
600	do	145	98.69	90	do	100	92.65	57.36	10.37
650	do	90	98.69	90	do	100	92.65	57.36	10.37
700	do		98.69	90	do	100	92.65	57.36	10.37
750	do	85	98.69	90	do	100	92.65	57.36	10.37
800	do		98.69	90	do	100	92.65	57.36	10.37

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1895.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Kind of cement.	Briquets.													
		Parts of sand to 1 of cement.	Water as per cent of dry ingredients.	Age 7 days.					Age 28 days.				
				Date made.	Tensile strength.			Number averaged.	Date made.	Tensile strength.			Number averaged.
					Mean.	Highest.	Lowest.			Mean.	Highest.	Lowest.	
	First shipment.												
55	Portland.	3	10	6, 5, 95	159	194	82	5	6, 5, 95	232	250	218	5
105	....do	3	10	6, 1, 95	120	140	100	5	6, 1, 95	198	235	147	5
155	....do	3	10	5, 29, 95	125	155	86	5	5, 29, 95	185	225	166	5
205	....do	3	10	5, 27, 95	87	122	70	5	5, 27, 95	167	186	144	5
255	....do	3	10	5, 24, 95	79	110	35	5	5, 24, 95	138	168	104	5
305	....do	3	10	5, 23, 95	110	134	65	5	5, 23, 95	219	290	136	4
355	....do	3	10	5, 20, 95	140	170	92	5	5, 20, 95	136	154	120	4
	Second shipment.												
50	Portland.	3	10	8, 9, 95	139	169	110	5	9, 7, 95	216	244	196	5
100	....do	3	10	8, 9, 95	205	229	166	4	9, 9, 95	231	260	210	4
150	....do	3	10	8, 12, 95	168	189	133	5	9, 10, 95	292	330	256	5
200	....do	3	10	8, 14, 95	145	186	120	5	9, 11, 95	230	270	200	4
250	....do	3	10	8, 14, 95	158	186	90	5	9, 18, 95	196	253	174	5
300	....do	3	10	8, 15, 95	128	146	92	5	9, 20, 95	209	260	174	5
350	....do	3	10	8, 16, 95	163	216	122	5	9, 24, 95	302	366	240	5
400	....do	3	10	8, 16, 95	149	170	120	5	10, 3, 95	327	402	290	5
450	....do	3	10	8, 20, 95	148	179	122	5	10, 4, 95	274	309	240	5
500	....do	3	10	8, 20, 95	140	162	128	4	10, 5, 95	263	314	212	5
550	....do	3	10	8, 21, 95	173	184	159	5	10, 7, 95	252	290	224	5
600	....do	3	10	8, 22, 95	99	120	79	5	10, 9, 95	244	284	184	5
650	....do	3	10	8, 22, 95	101	126	86	5	10, 10, 95	303	320	254	5
700	....do	3	10	8, 23, 95	154	190	122	5	10, 11, 95	255	320	180	5
750	....do	3	10	8, 24, 95	234	266	180	5	10, 17, 95	323	370	280	4
800	....do	3	10	8, 24, 95	218	271	180	4	10, 19, 95	251	300	210	5

No. of barrel.	Kind of cement.	Briquets.						Temperature of mixing room.	Molder.	Remarks.
		Age 6 months.					Percentage of increase in tensile strength.			
		Date made.	Tensile strength.			Number averaged.				
			Mean.	Highest.	Lowest.					
	First shipment.									
55	Portland.	6, 5, 95	237	260	220	5	49	65	M.	Medusa brand Sandusky cement.
105	....do	6, 1, 95	210	252	190	5	75	65	M.	Do.
155	....do	5, 29, 95	157	188	126	5	25.6	65	M.	Do.
205	....do	5, 27, 95	339	390	285	5	289.7	65	M.	Do.
255	....do	5, 24, 95	345	350	340	5	336.7	65	M.	Do.
305	....do	5, 23, 95	318	345	240	5	189.1	65	M.	Do.
355	....do	5, 20, 95	382	385	379	5	172.9	65	M.	Do.
	Second shipment.									
50	Portland.	9, 7, 95	254	328	190	4	82.7	65	M.	Do.
100	....do	9, 9, 95	287	336	247	5	40	65	M.	Do.
150	....do	9, 10, 95	307	336	273	5	83.3	65	M.	Do.
200	....do	9, 11, 95	277	310	240	5	91	65	M.	Do.
250	....do	9, 18, 95	264	286	224	4	67.1	65	M.	Do.
300	....do	9, 20, 95	283	371	220	5	121.1	65	M.	Do.
350	....do	9, 24, 95	355	388	300	5	117.8	65	M.	Do.
400	....do	10, 3, 95	434	472	421	5	191.3	65	M.	Do.
450	....do	10, 4, 95	374	430	348	5	152.7	65	M.	Do.
500	....do	10, 5, 95	340	406	266	5	142.9	65	M.	Do.
550	....do	10, 7, 95	365	414	334	4	111	65	M.	Do.
600	....do	10, 9, 95	333	441	257	5	236.4	65	M.	Do.
650	....do	10, 10, 95	446	473	397	4	341.5	65	M.	Do.
700	....do	10, 11, 95	363	422	294	5	135.7	65	M.	Do.
750	....do	10, 17, 95	359	417	314	4	53.4	65	M.	Do.
800	....do	10, 19, 95	483	505	460	2	126.8	65	M.	Do.

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1896.—CHARACTERISTICS OF CEMENT AND SAND.

No. of barrel.	Cement.					Sand.						Water as per cent of dry ingredients.
	Kind.	Time of setting.		Fineness.		Kind.	Fineness.				Parts to 1 of cement.	
		To bear $\frac{1}{12}$-inch wire, weighing $\frac{1}{4}$ pound.	To bear $\frac{1}{24}$-inch wire, weighing 1 pound.	Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.		Per cent passing No. 10 sieve.	Per cent passing No. 20 sieve.	Per cent passing No. 30 sieve.	Per cent passing No. 50 sieve.		
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*j*	*k*	*l*	*m*	*n*
		Min.	*Min.*									
60	Portland....	192	312	99.70	92.06	Lake ...	100	93.70	52.55	11.30	3	10
60	.....do	192	312	99.70	92.06	....do ...	100	93.70	52.55	11.30	3	10
60	.....do	192	312	99.70	92.06	....do ...	100	93.70	52.25	11.30	3	10
100	.....do	176	309	99.70	92.06	....do ...	100	93.70	52.55	11.30	3	10
100	.....do	176	309	99.70	92.06	....do ...	100	93.70	52.55	11.30	3	10
100	.....do	176	309	99.70	92.06	....do ...	100	93.70	52.55	11.30	3	10
160	Natural.....	23	55	90.15	80.72	....do ...	100	93.70	52.55	11.30	1	18.18
160	.....do	23	55	90.15	80.72	....do ...	100	93.70	52.55	11.30	3	12.50
160	.....do	23	55	90.15	80.72	....do ...	100	93.70	52.55	11.30	3	12.50
200	.....do	29	59	90.15	80.72	....do ...	100	93.70	52.55	11.30	1	18.18
200	.....do	29	59	90.15	80.72	....do ...	100	93.70	52.55	11.30	3	12.50
200	.....do	29	59	90.15	80.72	....do ...	100	93.70	52.55	11.30	3	12.50
260	Portland....	130	277	99.37	91.31	....do ...	100	93.70	52.55	11.30	3	10
260	.....do	130	277	99.37	91.31	....do ...	100	93.70	52.55	11.30	3	10
260	.....do	130	277	99.37	91.31	....do ...	100	93.70	52.55	11.30	3	10
300	Natural.....	23	53	89.76	77.90	....do ...	100	93.70	52.55	11.30	1	18.18
300	.....do	23	53	89.76	77.90	....do ...	100	93.70	52.55	11.30	3	12.50
300	.....do	23	53	89.76	77.90	....do ...	100	93.70	52.55	11.30	3	12.50
360	.....do	51	71	89.07	78.95	....do ...	100	93.70	52.55	11.30	1	18.18
360	.....do	51	71	89.07	78.95	....do ...	100	93.70	52.55	11.30	3	12.50
360	.....do	51	71	89.07	78.95	....do ...	100	93.70	52.55	11.30	3	12.50
400	.....do	48	71	91.59	79.87	....do ...	100	93.70	52.55	11.30	1	18.18
400	.....do	48	71	91.59	79.87	....do ...	100	93.70	52.55	11.30	3	12.50
400	.....do	48	71	91.59	79.87	....do ...	100	93.70	52.55	11.30	3	12.50
460	.....do	22	67	94.37	77.61	....do ...	100	93.70	52.55	11.30	1	18.18
460	.....do	22	67	94.37	77.61	....do ...	100	93.70	52.55	11.30	3	12.50
460	.....do	22	67	94.37	77.61	....do ...	100	93.70	52.55	11.30	3	12.50
500	.....do	29	79	93.43	78.50	....do ...	100	93.70	52.55	11.30	1	18.18
500	.....do	29	79	93.43	78.50	....do ...	100	93.70	52.55	11.30	3	12.50
500	.....do	29	79	93.43	78.50	....do ...	100	93.70	52.55	11.30	3	12.50
560	Portland....	95	202	98.98	93.34	....do ...	100	93.70	52.55	11.30	3	10
560	.....do	95	202	98.98	93.34	....do ...	100	93.70	52.55	11.30	3	10
560	.....do	95	202	98.98	93.34	....do ...	100	93.70	52.55	11.30	3	10
600	Natural.....	38	62	94.57	80.87	....do ...	100	93.70	52.55	11.30	1	18.18
600	.....do	38	62	94.57	80.87	....do ...	100	93.70	52.55	11.30	3	12.50
600	.....do	38	62	94.57	80.87	....do ...	100	93.70	52.55	11.30	3	12.50
660	.....do	30	56	94.76	81.43	....do ...	100	93.70	52.55	11.30	1	18.18
660	.....do	30	56	94.76	81.43	....do ...	100	93.70	52.55	11.30	3	12.50
660	.....do	30	56	94.76	81.43	....do ...	100	93.70	52.55	11.30	3	12.50
700	.....do	40	65	93.85	81.02	....do ...	100	93.70	52.55	11.30	1	18.18
700	.....do	40	65	93.85	81.02	....do ...	100	93.70	52.55	11.30	3	12.50
700	.....do	40	65	93.85	81.02	....do ...	100	93.70	52.55	11.30	3	12.50
760	.....do	40	55	93	80.43	....do ...	100	93.70	52.55	11.30	1	18.18
760	.....do	40	55	93	80.43	....do ...	100	93.70	52.55	11.30	3	12.50
760	.....do	40	55	93	80.43	....do ...	100	93.70	52.55	11.30	3	12.50
800	.....do	24	43	92.03	77.14	....do ...	100	93.70	52.55	11.30	1	18.18
800	.....do	24	43	92.03	77.14	....do ...	100	93.70	52.55	11.30	3	12.50
800	.....do	24	43	92.03	77.14	....do ...	100	93.70	52.55	11.30	3	12.50
860	.....do	20	36	93.97	81	....do ...	100	93.70	52.55	11.30	1	18.18
860	.....do	20	36	93.97	81	....do ...	100	93.70	52.55	11.30	3	12.50
860	.....do	20	36	93.97	81	....do ...	100	93.70	52.55	11.30	3	12.50
900	.....do	26	44	93.51	81.36	....do ...	100	93.70	52.55	11.30	1	18.18
900	.....do	26	44	93.51	81.36	....do ...	100	93.70	52.55	11.30	3	12.50
900	.....do	26	44	93.51	81.36	....do ...	100	93.70	52.55	11.30	3	12.50
960	.....do	28	52	93.51	79.37	....do ...	100	93.70	52.55	11.30	1	18.18
960	.....do	28	52	93.51	79.37	....do ...	100	93.70	52.55	11.30	3	12.50
960	.....do	28	52	93.51	79.37	....do ...	100	93.70	52.55	11.30	3	12.50
1000	.....do	49	59	95.12	82.01	....do ...	100	93.70	52.55	11.30	1	18.18
1000	.....do	49	59	95.12	82.01	....do ...	100	93.70	52.55	11.30	3	12.50
1000	.....do	49	59	95.12	82.01	....do ...	100	93.70	52.55	11.30	3	12.50
1040	.....do	25	52	95.50	83.10	....do ...	100	93.70	52.55	11.30	1	18.18
1040	.....do	25	52	95.50	83.10	....do ...	100	93.70	52.55	11.30	3	12.50
1040	.....do	25	52	95.50	83.10	....do ...	100	93.70	52.55	11.30	3	12.50
1100	.....do	39	61	93	80.92	....do ...	100	93.70	52.55	11.30	1	18.18
1100	.....do	39	61	93	80.92	....do ...	100	93.70	52.55	11.30	3	12.50
1100	.....do	39	61	93	80.92	....do ...	100	93.70	52.55	11.30	3	12.50

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTINGS, 1896.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Cement.					Sand.						
	Kind.	Time of setting.		Fineness.		Kind.	Fineness.				Parts to 1 of cement.	Water as per cent of dry ingredients.
		To bear $\frac{1}{12}$-inch wire, weighing $\frac{1}{4}$ pound.	To bear $\frac{1}{24}$-inch wire, weighing 1 pound.	Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.		Per cent passing No. 10 sieve.	Per cent passing No. 20 sieve.	Per cent passing No. 30 sieve.	Per cent passing No. 50 sieve.		
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*j*	*k*	*l*	*m*	*n*
		Min.	*Min.*									
1160	Natural	42	67	....	....	Lake ...	100	93.70	52.55	11.30	1	18.18
1160	.....do	42	67	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1160	.....do	42	67	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1200	.....do	39	81	92.86	79	....do ...	100	93.70	52.55	11.30	1	18.18
1200	.....do	39	81	92.86	79	....do ...	100	93.70	52.55	11.30	3	12.50
1200	.....do	39	81	92.86	79	....do ...	100	93.70	52.55	11.30	3	12.50
1260	.....do	59	89	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
1260	.....do	59	89	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1260	.....do	59	89	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1300	.....do	59	85	92	77.90	....do ...	100	93.70	52.55	11.30	1	18.18
1300	.....do	59	85	92	77.90	....do ...	100	93.70	52.55	11.30	3	12.50
1300	.....do	59	85	92	77.90	....do ...	100	93.70	52.55	11.30	3	12.50
1360	.....do	49	90	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
1360	.....do	49	90	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1360	.....do	49	90	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
1400	Portland....	111	256	99.30	92.17	....do ...	100	93.70	52.55	11.30	3	10
1400	.....do	111	256	99.30	92.17	....do ...	100	93.70	52.55	11.30	3	10
1400	.....do	111	256	99.30	92.17	....do ...	100	93.70	52.55	11.30	3	10
1460	.....do	133	228	....	....	....do ...	100	93.70	52.55	11.30	3	10
1460	.....do	133	228	....	....	....do ...	100	93.70	52.55	11.30	3	10
1460	.....do	133	228	....	....	....do ...	100	93.70	52.55	11.30	3	10
1500	.....do	147	300	99	90.53	....do ...	100	93.70	52.55	11.30	3	10
1500	.....do	147	300	99	90.53	....do ...	100	93.70	52.55	11.30	3	10
1500	.....do	147	300	99	90.53	....do ...	100	93.70	52.55	11.30	3	10
1560	.....do	140	......	....	....	....do ...	100	93.70	52.55	11.30	3	10
1560	.....do	140	......	....	....	....do ...	100	93.70	52.55	11.30	3	10
1560	.....do	140	......	....	....	....do ...	100	93.70	52.55	11.30	3	10
1600	.....do	196	373	99.45	91	....do ...	100	93.70	52.55	11.30	3	10
1600	.....do	196	373	99.45	91	....do ...	100	93.70	52.55	11.30	3	10
1600	.....do	196	373	99.45	91	....do ...	100	93.70	52.55	11.30	3	10
1660	.....do	124	203	....	....	....do ...	100	93.70	52.55	11.30	3	10
1660	.....do	124	203	....	....	....do ...	100	93.70	52.55	11.30	3	10
1660	.....do	124	203	....	....	....do ...	100	93.70	52.55	11.30	3	10
1700	.....do	150	333	99.18	90	....do ...	100	93.70	52.55	11.30	3	10
1700	.....do	150	333	99.18	90	....do ...	100	93.70	52.55	11.30	3	10
1700	.....do	150	333	99.18	90	....do ...	100	93.70	52.55	11.30	3	10
1760	.....do	152	334	....	....	....do ...	100	93.70	52.55	11.30	3	10
1760	.....do	152	334	....	....	....do ...	100	93.70	52.55	11.30	3	10
1760	.....do	152	334	....	....	....do ...	100	93.70	52.55	11.30	3	10
1800	.....do	171	358	99	90	....do ...	100	93.70	52.55	11.30	3	10
1800	.....do	171	358	99	90	....do ...	100	93.70	52.55	11.30	3	10
1800	.....do	171	358	99	90	....do ...	100	93.70	52.55	11.30	3	10
1860	.....do	123	303	....	....	....do ...	100	93.70	52.55	11.30	3	10
1860	.....do	123	303	....	....	....do ...	100	93.70	52.55	11.30	3	10
1860	.....do	123	303	....	....	....do ...	100	93.70	52.55	11.30	3	10
1900	.....do	143	329	99	91.31	....do ...	100	93.70	52.55	11.30	3	10
1900	.....do	143	329	99	91.31	....do ...	100	93.70	52.55	11.30	3	10
1900	.....do	143	329	99	91.31	....do ...	100	93.70	52.55	11.30	3	10
1960	.....do	222	315	....	....	....do ...	100	93.70	52.55	11.30	3	10
1960	.....do	222	315	....	....	....do ...	100	93.70	52.55	11.30	3	10
1960	.....do	222	315	....	....	....do ...	100	93.70	52.55	11.30	3	10
2000	.....do	180	292	99.15	91.87	....do ...	100	93.70	52.55	11.30	3	10
2000	.....do	180	292	99.15	91.87	....do ...	100	93.70	52.55	11.30	3	10
2000	.....do	180	292	99.15	91.87	....do ...	100	93.70	52.55	11.30	3	10
2060	.....do	169	281	....	....	....do ...	100	93.70	52.55	11.30	3	10
2060	.....do	169	281	....	....	....do ...	100	93.70	52.55	11.30	3	10
2060	.....do	169	281	....	....	....do ...	100	93.70	52.55	11.30	3	10
2100	.....do	187	284	99.38	93.04	....do ...	100	93.70	52.55	11.30	3	10
2100	.....do	187	284	99.38	93.04	....do ...	100	93.70	52.55	11.30	3	10
2100	.....do	187	284	99.38	93.04	....do ...	100	93.70	52.55	11.30	3	10
2160	.....do	208	296	....	....	....do ...	100	93.70	52.55	11.30	3	10
2160	.....do	208	296	....	....	....do ...	100	93.70	52.55	11.30	3	10
2160	.....do	208	296	....	....	....do ...	100	93.70	52.55	11.30	3	10
2200	.....do	219	296	98.84	90.83	....do ...	100	93.70	52.55	11.30	3	10
2200	.....do	219	296	98.84	90.83	....do ...	100	93.70	52.55	11.30	3	10
2200	.....do	219	296	98.84	90.83	....do ...	100	93.70	52.55	11.30	3	10

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1896.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Cement.					Sand.						Water as per cent of dry ingredients.
	Kind.	Time of setting.		Fineness.		Kind.	Fineness.				Parts to 1 of cement.	
		To bear $\frac{1}{12}$-inch wire, weighing ¼ pound.	To bear $\frac{1}{24}$-inch wire, weighing 1 pound.	Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.		Per cent passing No. 10 sieve.	Per cent passing No. 20 sieve.	Per cent passing No. 30 sieve.	Per cent passing No. 50 sieve.		
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*j*	*k*	*l*	*m*	*n*
		Min.	*Min.*									
2260	Portland....	164	More than 312 min.	....	....	....do ...	100	93.70	52.55	11.30	3	10
2260	.....do	164		....	....	....do ...	100	93.70	52.55	11.30	3	10
2260	.....do	164		....	....	....do ...	100	93.70	52.55	11.30	3	10
2300	.....do	155		99.42	92	....do ...	100	93.70	52.55	11.30	3	10
2300	.....do	155		99.42	92	....do ...	100	93.70	52.55	11.30	3	10
2300	.....do	155		99.42	92	....do ...	100	93.70	52.55	11.30	3	10
2360	.....do	170		....	....	....do ...	100	93.70	52.55	11.30	3	10
2360	.....do	170		....	....	....do ...	100	93.70	52.55	11.30	3	10
2360	.....do	170		....	....	....do ...	100	93.70	52.55	11.30	3	10
2400	.....do	85	128	98.85	88.84	....do ...	100	93.70	52.55	11.30	3	10
2400	.....do	85	128	98.85	88.84	....do ...	100	93.70	52.55	11.30	3	10
2400	.....do	85	128	98.85	88.84	....do ...	100	93.70	52.55	11.30	3	10
2460	Natural	64	98	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2460	.....do	64	98	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
2460	.....do	64	98	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
2500	.....do	64	69	93	80.59	....do ...	100	93.70	52.55	11.30	1	18.18
2500	.....do	64	69	93	80.59	....do ...	100	93.70	52.55	11.30	3	12.50
2500	.....do	64	69	93	80.59	....do ...	100	93.70	52.55	11.30	3	12.50
2560	.....do	60	100	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2560	.....do	60	100	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
2560	....do	60	100	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
2600	.....do	69	108	94.08	82.29	....do ...	100	93.70	52.55	11.30	1	18.18
2000	.....do	69	108	94.08	82.29	....do ...	100	93.70	52.55	11.30	3	12.50
2600	.....do	69	108	94.08	82.29	....do ...	100	93.70	52.55	11.30	3	12.50
2660	.....do	62	105	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2660	.....do	62	105	....	....	....do ...	100	93.70	52.55	11.30	3	12.50
2660	....do	62	105	....	....	....do ...	100	93.70	52.55	11.30	3	12.50

No. of barrel.	Kind of cement.	Date made.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Remarks.
				Mean.	Highest.	Lowest.	No. averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
a	*b*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	
60	Portland..	7, 18, 96	7 days ...	203	230	190	5	....	70	63	65	65	S.	
60	.....do	7, 20, 96	28 days ..	309	339	280	5	....	70	63	63	65	S.	
60	.....do	7, 22, 96	6 months.	401	432	383	5	97.54	68	63	68	63	S.	Percentage of increase is from 7 days to 6 months.
100	.....do	7, 8, 96	7 days ...	222	248	188	5	....	77	63	67	72	S.	
100	.....do	7, 21, 96	28 days ..	326	300	350	5	....	70	63	65	65	S.	
100	.....do	7, 22, 96	6 months.	416	465	380	5	87.37	70	63	65	65	S.	Do.
160	Natural...	7, 23, 96	7 days ...	98	117	88	5	....	68	63	65	63	S.	
160	.....do	8, 18, 96	28 days ..	186	204	166	5	....	74	63	65	69	S.	
160	.....do	8, 15, 96	6 months.	261	280	252	5	40.32	74	63	65	69	S.	Percentage of increase is from 28 days to 6 months.
200	.....do	7, 24, 96	7 days ...	126	150	113	5	....	67	63	64	62	S.	
200	.....do	8, 8, 96	28 days ..	192	208	171	5	....	76	63	65	71	S.	
200	.....do	8, 15, 96	6 months.	315	376	276	5	64.06	73	63	65	68	S.	Do.
260	Portland..	7, 31, 96	7 days ...	155	173	140	5	....	70	63	66	65	S.	
260	.....do	8, 1, 96	28 days ..	290	302	278	5	....	68	63	65	63	S.	
260	.....do	8, 3, 96	6 months.	407	426	376	5	162.52	76	63	67	71	S.	Percentage of increase is from 7 days to 6 months.

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1896.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Kind of cement.	Date made.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Remarks.
				Mean.	Highest.	Lowest.	No. averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
a	b	o	p	q	r	s	t	u	v	w	x	y	z	
300	Natural...	7, 25, 96	7 days ...	99	109	86	5	....	76	63	66	71	S.	
300	.....do	8, 20, 96	28 days ..	138	159	121	5	....	65	63	65	60	S.	
300	.....do	8, 21, 96	6 months.	249	285	227	5	80.43	65	63	65	60	S.	Percentage of increase is from 28 days to 6 months.
360	.....do	7, 27, 96	7 days ...	82	88	75	5	....	70	63	65	65	S.	
360	.....do	9, 8, 96	28 days ..	123	139	110	5	....	73	63	63	68	S.	
360	.....do	9, 8, 96	6 months.	245	273	224	5	99.18	73	63	65	68	S.	Do.
400	.....do	7, 28, 96	7 days ...	74	79	70	5	....	66	63	64	61	S.	
400	.....do	9, 9, 96	28 days ..	99	118	89	5	....	70	63	65	65	S.	
400	.....do	9, 9, 96	6 months.	255	279	243	5	157.57	73	63	65	68	S.	Do.
460	.....do	8, 5, 96	7 days ...	69	74	63	5	....	70	63	65	65	S.	
460	.....do	9, 10, 96	28 days ..	67	80	61	5	....	66	63	65	61	S.	
460	.....do	9, 11, 96	6 months.	261	276	251	5	289.55	61	63	66	56	S.	Do.
500	.....do	8, 6, 96	7 days ...	61	72	52	5	....	71	63	65	66	S.	
500	.....do	9, 10, 96	28 days ..	82	89	72	5	....	65	63	65	60	S.	
500	.....do	9, 15, 96	6 months.	289	327	274	5	252.44	72	63	64	67	S.	Do.
560	Portland..	9, 6, 96	7 days ...	220	230	191	5	....	75	63	65	70	S.	
560	.....do	9, 10, 96	28 days ..	305	335	286	5	....	65	63	65	60	S.	
560	.....do	9, 15, 96	6 months.	467	485	434	5	112.27	72	63	64	67	S.	Percentage of increase is from 7 days to 6 months.
600	Natural...	8, 8, 96	7 days ...	81	83	79	5	....	78	63	65	73	S.	
600	.....do	9, 16, 96	28 days ..	145	158	126	5	....	76	63	65	71	S.	
600	.....do	9, 17, 96	6 months.	355	371	336	5	144.83	72	63	66	67	S.	Percentage of increase is from 28 days to 6 months.
660	.....do	8, 10, 96	7 days ...	123	139	101	5	....	77	63	65	72	S.	
660	.....do	9, 16, 96	28 days ..	163	176	150	5	....	71	63	65	66	S.	
660	.....do	9, 17, 96	6 months.	223	317	200	5	36.81	72	63	66	67	S.	Do.
700	.....do	8, 10, 96	7 days ...	106	127	72	5	....	77	63	65	72	S.	
700	.....do	9, 18, 96	28 days ..	151	178	134	5	....	64	63	65	59	S.	
700	.....do	9, 19, 96	6 months.	318	370	279	5	110.60	64	63	65	59	S.	Do.
760	.....do	8, 11, 96	7 days ...	95	106	84	5	....	77	63	65	72	S.	
760	.....do	9, 18, 96	28 days ..	139	149	126	5	....	65	63	65	60	S.	
760	.....do	9, 19, 96	6 months.	315	328	294	5	126.62	66	63	65	61	S.	Do.
800	.....do	8, 11, 96	7 days ...	90	98	86	5	....	77	63	65	72	S.	
800	.....do	9, 21, 96	28 days ..	158	169	144	5	....	73	63	65	68	S.	
800	.....do	9, 21, 96	6 months.	317	354	288	5	100.63	72	63	65	67	S.	Do.
860	.....do	8, 12, 96	7 days ...	104	110	96	5	....	68	63	65	63	S.	
860	.....do	9, 21, 96	28 days ..	181	193	171	5	....	71	63	65	66	S.	
860	.....do	9, 21, 96	6 months.	265	284	220	5	46.41	70	63	65	65	S.	Do.
900	.....do	8, 12, 96	7 days ...	129	150	116	5	....	68	63	65	63	S.	
900	.....do	9, 22, 96	28 days ..	184	201	162	5	....	72	63	65	67	S.	
900	.....do	9, 23, 96	6 months.	253	294	221	5	36.51	75	63	65	70	S.	Do.
960	.....do	8, 13, 96	7 days....	81	92	72	5	....	65	63	65	60	S.	
960	.....do	9, 22, 96	28 days...	109	116	106	5	....	74	63	65	69	S.	
960	.....do	9, 23, 96	6 months.	331	347	273	5	202.75	75	63	66	70	S.	Do.
1000	.....do	8, 13, 96	7 days....	114	124	106	5	....	66	63	65	61	S.	
1000	.....do	9, 24, 96	28 days...	195	205	173	5	....	64	63	65	59	S.	
1000	.....do	9, 25, 96	6 months.	302	356	252	5	106.15	63	63	65	58	S.	
1040	.....do	8, 13, 96	7 days....	133	144	120	5	....	68	63	65	63	S.	
1040	.....do	9, 24, 96	28 days...	188	209	172	5	....	64	63	65	59	S.	
1040	.....do	9, 25, 96	6 months.	293	338	273	5	55.85	68	63	65	63	S.	
1100	.....do	8, 17, 96	7 days....	78	80	76	5	....	65	63	65	60	S.	
1100	.....do	9, 26, 96	28 days...	126	144	111	5	....	64	63	66	59	S.	
1100	.....do	9, 28, 96	6 months.	323	397	301	5	156.35	63	63	65	58	S.	
1160	.....do	8, 17, 96	7 days....	69	72	64	4	....	65	63	65	60	S.	
1160	.....do	9, 26, 96	28 days...	115	123	104	5	....	70	63	66	65	S.	
1160	.....do	9, 28, 96	6 months.	302	318	277	5	162.61	69	63	65	64	S.	
1200	.....do	8, 18, 96	7 days....	69	78	47	5	....	63	63	65	58	S.	
1200	.....do	9, 29, 96	28 days...	98	107	92	5	....	62	63	64	57	S.	
1200	.....do	9, 30, 96	6 months.	303	311	288	5	209.18	65	63	64	60	S.	
1260	.....do	8, 18, 96	7 days....	91	98	80	5	....	63	63	65	58	S.	
1260	.....do	9, 29, 96	28 days...	160	179	134	5	....	67	63	64	62	S.	
1260	.....do	9, 30, 96	6 months.	301	324	282	5	88.12	65	63	64	60	S.	
1300	.....do	8, 19, 96	7 days....	153	164	140	5	....	60	63	65	55	S.	
1300	.....do	10, 1, 96	28 days...	148	167	120	5	....	71	63	66	66	S.	
1300	.....do	10, 1, 96	6 months.	280	297	258	5	89.19	72	63	66	67	S.	

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1896.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Kind of cement.	Date made.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Remarks.
				Mean.	Highest.	Lowest.	No average.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
a	*b*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	
1360	Natural	8, 19, 96	7 days	85	96	74	5	....	63	63	65	58	S.	
1360	do	10, 1, 96	28 days	103	120	91	5	....	72	63	66	67	S.	
1360	do	10, 1, 96	6 months	295	320	268	5	186.41	68	63	66	63	S.	
1400	Portland	8, 19, 96	7 days	233	266	206	5	....	74	63	65	69	S.	
1400	do	10, 12, 96	28 days	291	328	261	5	....	72	63	66	67	S.	
1400	do	10, 13, 96	6 months	433	489	370	5	85.84	68	63	67	63	S.	Percentage of increase is from 7 days to 6 months.
1400	do	8, 20, 96	7 days	226	250	204	5	....	65	63	65	60	S.	
1460	do	10, 12, 96	28 days	277	310	255	5	....	70	63	66	65	S.	
1460	do	10, 13, 96	6 months	435	460	374	5	92.48	70	63	67	65	S.	
1500	do	8, 21, 96	7 days	276	292	258	5	....	65	63	65	60	S.	
1500	do	10, 14, 96	3 months	401	430	351	5	....	71	63	65	66	S.	
1500	do	10, 15, 96	6 months	405	433	370	5	46.74	67	63	65	62	S.	
1560	do	8, 22, 96	7 days	218	234	206	5	....	65	63	65	60	S.	
1560	do	10, 14, 96	3 months	362	375	352	5	....	73	63	65	68	S.	
1560	do	10, 15, 96	6 months	409	428	399	5	87.61	67	63	65	62	S.	
1600	do	8, 22, 96	7 days	208	222	191	5	....	65	63	65	60	S.	
1600	do	10, 16, 96	3 months	366	400	335	5	....	67	63	65	62	S.	
1600	do	10, 18, 96	6 months	398	454	364	5	91.34	71	63	67	66	S.	
1660	do	8, 24, 96	7 days	202	218	170	5	....	65	63	65	60	S.	
1660	do	10, 16, 96	3 months	367	396	340	5	....	71	63	65	66	S.	
1660	do	10, 18, 96	6 months	413	424	389	5	104.45	72	63	67	67	S.	
1700	do	8, 24, 96	7 days	235	264	206	5	....	66	63	65	61	S.	
1700	do	10, 22, 96	3 months	320	333	297	5	....	68	63	65	63	S.	
1700	do	10, 23, 96	6 months	423	469	389	5	80	68	63	65	63	S.	
1760	do	8, 27, 96	7 days	309	322	284	5	....	63	63	65	58	S.	
1760	do	10, 22, 96	3 months	358	377	331	5	....	70	63	65	65	S.	
1760	do	10, 23, 96	6 months	452	487	425	5	46.21	64	63	65	59	S.	
1800	do	8, 27, 96	7 days	211	246	196	5	....	63	63	65	58	S.	
1800	do	10, 24, 96	3 months	352	379	312	5	....	67	63	65	62	S.	
1800	do	10, 27, 96	6 months	388	432	354	5	83.89	65	63	65	60	S.	
1860	do	8, 29, 96	7 days	211	244	188	5	....	68	63	65	63	S.	
1860	do	10, 24, 96	3 months	335	417	303	5	....	67	63	65	62	S.	
1860	do	10, 27, 96	6 months	379	406	350	5	79.62	72	63	65	67	S.	
1900	do	8, 29, 96	7 days	212	234	189	5	....	71	63	65	66	S.	
1900	do	10, 29, 96	28 days	238	260	222	5	....	69	63	66	64	S.	
1900	do	10, 28, 96	6 months	357	376	324	5	68.40	74	63	66	69	S.	
1960	do	9, 2, 96	7 days	255	268	233	5	....	66	63	65	61	S.	
1960	do	10, 29, 96	28 days	296	302	287	5	....	70	63	66	65	S.	
1960	do	10, 28, 96	6 months	386	452	334	5	51.37	72	63	66	67	S.	
2000	do	9, 3, 96	7 days	210	222	199	5	....	66	63	65	61	S.	
2000	do	12, 1, 96	28 days	278	309	241	5	....	68	63	66	63	S.	
2000	do	12, 1, 96	6 months	427	486	396	5	103.33	65	63	65	60	S.	Percentage of increase is from 7 days to 6 months.
2060	do	9, 3, 96	7 days	210	234	194	5	....	68	63	65	63	S.	
2060	do	12, 3, 96	28 days	332	346	317	5	....	70	63	67	65	S.	
2060	do	12, 4, 96	6 months	438	472	392	5	108.57	72	63	67	67	S.	Do.
2100	do	9, 4, 96	3 days	160	170	150	5	....	63	63	65	60	S.	
2100	do	12, 3, 96	28 days	332	353	305	5	....	64	63	67	59	S.	
2100	do	12, 4, 96	6 months	465	500	420	5	190.63	67	63	66	62	S.	Do.
2160	do	9, 5, 96	7 days	225	274	172	5	....	68	63	65	63	S.	
2160	do	12, 5, 96	28 days	316	333	303	5	....	69	63	64	64	S.	
2160	do	12, 7, 96	6 months	429	460	410	5	90.67	70	63	65	65	S.	Do.
2200	do	9, 5, 96	7 days	209	276	160	5	....	73	63	65	68	S.	
2200	do	12, 5, 96	28 days	309	347	271	5	....	66	63	65	61	S.	
2200	do	12, 7, 96	6 months	424	441	400	5	102.87	66	63	65	61	S.	Do.
2260	do	9, 7, 96	7 days	210	232	190	5	....	64	63	65	59	S.	
2260	do	12, 8, 96	28 days	311	356	294	5	....	66	63	66	61	S.	
2260	do	12, 9, 96	6 months	442	489	416	5	110.48	66	63	66	61	S.	Do.
2300	do	9, 7, 96	7 days	263	280	236	5	....	65	63	65	60	S.	
2300	do	12, 8, 96	28 days	382	392	377	5	....	67	63	66	62	S.	
2300	do	12, 9, 96	6 months	419	457	403	5	59.32	68	63	66	63	S.	Do.
2360	do	9, 8, 96	7 days	263	274	244	5	....	67	63	65	62	S.	
2360	do	12, 10, 96	28 days	334	352	307	5	....	70	63	65	65	S.	
2360	do	12, 11, 96	6 months	410	440	397	5	55.89	70	63	66	65	S.	Do.
2400	do	9, 8, 96	7 days	182	204	160	5	....	73	63	65	68	S.	
2460	do	12, 10, 96	28 days	251	273	233	5	....	65	63	65	60	S.	
2400	do	12, 11, 96	6 months	380	400	360	5	108.79	68	63	66	63	S.	Do.

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

CEMENT TESTING, 1896.—CHARACTERISTICS OF CEMENT AND SAND—Continued.

No. of barrel.	Kind of cement.	Date made.	Age.	Tensile strength.				Percentage of increase in tensile strength.	Temperature.				Molder.	Remarks.
				Mean.	Highest.	Lowest.	No. averaged.		Air of mixing room.	Water in tank.	Water for mixing.	Dry ingredients.		
a	*b*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	
2460	Natural...	8, 25, 96	7 days ...	80	96	70	5	....	67	63	65	62	S.	
2460	.....do	12, 12, 96	28 days ..	166	188	138	5	....	67	63	65	62	S.	
2460	.....do	12, 14, 96	6 months.	378	400	357	5	127.77	69	63	65	64	S.	Percentage of increase is from 28 days to 6 months.
2500	.....do	8, 25, 96	7 days ...	88	110	72	5	....	73	63	65	68	S.	
2500	.....do	12, 12, 96	28 days ..	192	200	176	5	....	67	63	65	62	S.	
2500	.....do	12, 14, 96	6 months.	367	397	306	5	91.14	69	63	65	64	S.	Do.
2560	.....do	8, 26, 96	7 days ...	81	84	78	5	....	64	63	65	59	S.	
2560	.....do	12, 15, 66	28 days ..	179	201	164	5	....	67	63	66	62	S.	
2560	.....do	12, 16, 96	6 months.	355	368	314	5	98.32	67	63	65	62	S.	Do.
2600	.....do	8, 26, 96	7 days ...	86	90	82	5	....	65	63	65	60	S.	
2600	.....do	12, 17, 96	28 days ..	165	198	138	5	....	68	63	65	63	S.	
2600	.....do	12, 18, 96	6 months.	329	346	316	5	99.40	67	63	64	62	S.	Do.
2660	.....do	10, 2, 96	7 days ...	125	140	111	5	....	71	63	65	66	S.	
2660	.....do	12, 17, 96	28 days ..	195	228	166	5	....	69	63	65	64	S.	
2660	.....do	12, 18, 96	6 months.	351	380	340	5	66.67	69	63	64	64	S.	Do.

TESTS TO SHOW EFFECT OF AGE OF CEMENT ON TENSILE STRENGTH. (BRIQUETS SEVEN DAYS OLD.)

No. of barrel.	Cement.			Sand.					Parts to one of cement.	Water as per cent of dry ingredients.
	Kind.	Fineness.		Kind.	Fineness.					
		Per cent passing No. 50 sieve.	Per cent passing No. 100 sieve.		Per cent passing No. 10 sieve.	Per cent passing No. 20 sieve.	Per cent passing No. 30 sieve.	Per cent passing No. 50 sieve.		
1940	Portland......	96.66	94.36	Lake ...	100	93.70	52.55	11.30	3	10.00
1990	.....do	99.64	93.05	....do ...	100	93.70	52.55	11.30	3	10.00
2050	.....do	99.45	94.54	....do ...	100	93.70	52.55	11.30	3	10.00
2100	.....do	99.38	93.04	....do ...	100	93.70	52.55	11.30	3	10.00
2170	.....do	99.50	92.51	....do ...	100	93.70	52.55	11.30	3	10.00
2350	.....do	99.14	91.24	....do ...	100	93.70	52.55	11.30	3	10.00
2440	Natural.......	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2480	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2650	.....do	95.59	79.88	....do ...	100	93.70	52.55	11.30	1	18.18
2700	.....do	96.00	87.42	....do ...	100	93.70	52.55	11.30	1	18.18
2760	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2810	.....do	92.98	79.10	....do ...	100	93.70	52.55	11.30	1	18.18
2860	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
2910	.....do	95.45	83.46	....do ...	100	93.70	52.55	11.30	1	18.18
2960	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3010	.....do	97.00	87.58	....do ...	100	93.70	52.55	11.30	1	18.18
3060	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3110	.....do	96.50	84.05	....do ...	100	93.70	52.55	11.30	1	18.18
3160	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3210	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3260	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3310	.....do	93.59	79.30	....do ...	100	93.70	52.55	11.30	1	18.18
3360	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3410	.....do	92.04	79.11	....do ...	100	93.70	52.55	11.30	1	18.18
3460	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3510	.....do	91.48	78.10	....do ...	100	93.70	52.55	11.30	1	18.18
3560	.....do	....	....	....do ...	100	93.70	52.55	11.30	1	18.18
3610	.....do	91.98	79.34	....do ...	100	93.70	52.55	11.30	1	18.18

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

TESTS TO SHOW EFFECT OF AGE OF CEMENT ON TENSILE STRENGTH, ETC.—Cont'd.

No. of barrel.	Kind of cement.	First sample.						
		Time of setting of cement.		Date on which briquet was made.	Tensile strength.			
		To bear $\frac{1}{12}$-inch wire, weighing $\frac{1}{4}$ pound.	To bear $\frac{1}{24}$-inch wire, weighing 1 pound.		Mean.	Highest.	Lowest.	Number averaged.
1940	Portland......	229	322	9, 2, 96	230	246	222	5
1990	.....do	....	....	9, 2, 96	245	250	236	5
2050	.....do	....	....	9, 3, 96	233	246	220	5
2100	.....do	187	284	9, 4, 96	160	170	150	5
2170	.....do	....	....	9, 5, 96	260	298	198	5
2350	.....do	....	....	9, 8, 96	225	238	214	5
2440	Natural.......	60	98	8, 25, 96	139	170	86	5
2480	.....do	67	99	8, 25, 96	132	154	74	5
2650	.....do	....	....	8, 27, 96	103	116	88	5
2700	.....do	56	74	10, 2, 96	127	139	117	5
2760	.....do	55	80	10, 8, 96	137	144	125	5
2810	.....do	....	....	10, 3, 96	77	80	74	5
2860	.....do	37	77	10, 5, 96	69	76	60	5
2910	.....do	....	....	10, 5, 96	78	85	73	5
2960	.....do	50	74	10, 6, 96	99	102	96	5
3010	.....do	....	....	10, 6, 96	81	96	68	5
3060	.....do	51	88	10, 7, 96	96	121	76	5
3110	.....do	47	84	10, 7, 96	130	141	114	5
3160	.....do	50	76	10, 8, 96	131	139	128	5
3210	.....do	....	....	10, 8, 96	72	79	69	5
3260	.....do	48	86	10, 9, 96	91	108	76	5
3310	.....do	....	....	10, 17, 96	61	67	56	5
3360	.....do	43	72	10, 17, 96	66	72	61	5
3410	.....do	....	....	10, 18, 96	64	78	58	5
3460	.....do	52	79	10, 20, 96	61	64	59	5
3510	.....do	....	....	10, 20, 96	69	72	67	5
3560	.....do	49	79	10, 21, 96	65	70	59	5
3610	.....do	....	....	10, 21, 96	72	74	65	5

No. of barrel.	Kind of cement.	Second sample.						
		Time of setting of cement.		Date on which briquet was made.	Tensile strength.			
		To bear $\frac{1}{12}$-inch wire weighing $\frac{1}{4}$ pound.	To bear $\frac{1}{24}$-inch wire weighing 1 pound.		Mean.	Highest.	Lowest.	Number averaged.
1940	Portland......	56	127	4, 24, 97	245	271	216	5
1990	.....do	....	....	4, 24, 97	261	279	228	5
2050	.....do	....	....	4, 24, 97	246	268	231	5
2100	.....do	54	125	4, 24, 97	257	284	232	5
2170	.....do	....	....	4, 24, 97	280	300	255	5
2350	.....do	....	....	4, 24, 97	232	256	215	5
2440	Natural.......	52	84	4, 24, 97	173	219	136	5
2480	.....do	49	86	4, 24, 97	168	181	148	5
2650	.....do	....	....	4, 24, 97	123	126	119	5
2700	.....do	36	62	4, 24, 97	169	179	144	5
2760	.....do	37	61	4, 26. 97	106	118	96	5
2810	.....do	....	....	4, 26, 97	90	98	82	5
2860	.....do	46	68	4, 26, 97	93	111	77	5
2910	.....do	....	....	4, 26, 97	105	117	90	5
2960	.....do	42	69	4, 26, 97	97	110	82	5
3010	.....do	....	....	4, 26, 97	105	115	81	5
3060	.....do	45	71	4, 26, 97	102	113	87	5
3110	.....do	44	69	4, 26, 97	134	148	118	5
3160	.....do	44	67	4, 26, 97	131	138	120	5
3210	.....do	....	....	4, 26, 97	97	110	85	5
3260	.....do	39	62	4, 27, 97	94	99	86	5
3310	.....do	....	....	4, 27, 97	110	115	107	5
3360	.....do	43	70	4, 27, 97	114	127	105	5
3410	.....do	....	....	4, 27, 97	121	139	110	5
3460	.....do	45	71	4, 27, 97	108	112	105	5
3510	.....do	....	....	4, 27, 97	110	113	109	5
3560	.....do	47	84	4, 27, 97	109	112	106	5
3610	.....do	....	....	4, 27, 97	112	118	107	5

Concrete superstructure to breakwater at Marquette, Mich.—Continued.

TESTS TO SHOW EFFECT OF AGE OF CEMENT ON TENSILE STRENGTH, ETC.—Cont'd.

No. of barrel.	Kind of cement.	Change in strength.				Temperatures.				Molder.	Remarks.
		Increase.		Decrease.		First sample.		Second sample.			
		Pounds.	Per cent.	Pounds.	Per cent.	Air of mixing room.	Water for mixing.	Air of mixing room.	Water for mixing.		
1940	Portland	15	6.52			66	65	66	65	S.	
1990	do	16	6.53			66	65	66	65	S.	
2050	do	13	5.58			67	65	66	65	S.	
2100	do	97	60.62			63	65	66	65	S.	First sample broken—3 days old.
2170	do	20	7.69			68	65	66	65	S.	
2350	do	7	3.11			66	65	66	65	S.	
2440	Natural	34	24.46			66	65	66	65	S.	
2480	do	36	27.27			69	65	66	65	S.	
2650	do	20	19.42			63	65	66	65	S.	
2700	do	42	33.07			72	65	66	65	S.	
2760	do			31	22.63	71	65	67	65	S.	
2810	do	18	16.88			70	65	67	65	S.	
2860	do	24	35.36			68	67	67	65	S.	
2910	do	27	34.61			68	65	67	65	S.	
2960	do			2	2.02	70	65	67	65	S.	
3010	do	24	29.63			71	65	67	65	S.	
3060	do	6	6.25			69	65	67	65	S.	
3110	do	4	3.08			68	65	67	65	S.	
3160	do	0		0		69	64	67	65	S.	
3210	do	25	34.72			67	64	67	65	S.	
3260	do	8	8.30			72	65	70	65	S.	
3310	do	49	80.33			70	65	70	65	S.	
3360	do	48	72.73			68	65	70	65	S.	
3410	do	57	89.39			72	65	70	65	S.	
3460	do	47	77.05			71	65	70	65	S.	
3510	do	41	59.42			68	65	70	65	S.	
3560	do	44	67.69			68	66	70	65	S.	
3610	do	40	55.55			71	66	70	65	S.	
	Mean increase, Portland.		12.41								
	Mean increase, natural.		27.27								

CONSTRUCTION OF CONCRETE SUPERSTRUCTURE TO BREAKWATER, MARQUETTE, MICH.

TABLE NO. 1.—*Labor, superintendence, and materials, quantities and cost, composing concrete in place, 1896.*

Kind of work.	Portland cement.		Natural cement.		Broken stone.		Stone screenings.	
	Barrels.	Cost.	Barrels.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Monolithic concrete blocks			1,780	$1,901.04	963.5	$1,559.91	53.50	$20.97
Subaqueous concrete foundation	453	$1,190.03			375	607.13		
Concrete footing	126	331.00			104.75	169.59		
Gallery floor	29	76.18					24.10	9.45
Repairs with concrete	75	197.02					62.29	24.41
Total expended material	683	1,794.23	1,780	1,901.04	1,443.25	2,336.63	139.89	54.83

TABLE No. 1.—*Labor, superintendence, and materials, etc.*—Continued.

Kind of work.	Sand.		Rubblestone.		Iron.		Burlap.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Pounds.	Cost.	Yards.	Cost.
Monolithic concrete blocks	485.61	$190.86	214.27	....	407.5	$61.12	....	....
Subaqueous concrete foundation	180	70.56	....	....	....	....	3,220	$106.39
Concrete footing	52.37	20.52	....	....	....	....	1,610	53.19
Gallery floor	11.57	4.53	....	....	....	....	....	....
Repairs with concrete	29.90	11.72	....	....	....	....	....	....
Total expended material	759.45	297.69	214.27	....	407.5	61.12	4,830	159.58

Kind of work.	Tarred paper.		Gas pipe.		Cost of twine and needles.	Tacks.	
	Pounds.	Cost.	Linear feet.	Cost.		Packages.	Cost.
Monolithic concrete blocks	1,125	$12.07	6″– 6 ¾″– 76	$1.50 2.66	....	24	$0.80
Subaqueous concrete foundation	....	....	....	....	$6.36	....	....
Concrete footing	....	....	....	....	3.18	....	....
Gallery floor	....	....	....	....	....	....	....
Repairs with concrete	....	....	....	....	....	....	....
Total expended material	1,125	12.07	82	4.16	9.54	24	.80

Kind of work.	Total cost of materials.	Superintendence and labor.			Concrete in place.	
		Mixing.	Depositing.	Total cost.	Cubic yards.	Cost per cubic yard.
Monolithic concrete blocks	$3,750.43	$856.18	$458.72	$1,314.90	1,231.528	$4.113
Subaqueous concrete foundation	1,980.47	342.22	211.72	553.94	375	6.763
Concrete footing	577.48	....	....	214.99	104.750	7.564
Gallery floor	90.16	....	....	58.80	24.100	6.230
Repairs with concrete	233.15	....	....	250.17	62.290	7.919
Total expended material	6,631.69	1,198.40	....	2,392.80	1,797.668	*5.02

* Average.

TABLE No. 2.—*Cost of labor and materials auxiliary to concrete work, 1896.*

Designation.	Superintendence and labor.	Materials.	Charged to concrete, 1896.	Per cent charged to concrete, 1896.
Removing crib superstructure	$906.45	$103.00	$1,009.45	....
Moving and setting concrete forms	358.80	....	358.80	....
Trestles and railroad tracks	623.40	....	623.40	....
Depositing riprap for cribs	509.12	....	....	50.91
Temporary timber work	416.50	35.86	452.36	....
Repairs to plant	662.75	213.16	....	87.59
Erection of concrete shed	65.46	178.24	....	24.37
Construction of boat	39.00	20.99	....	6.00
Constructing stone bin and grading	46.30	54.99	....	10.18
Constructing standard form	117.00	57.12	....	17.41
Care and storing plant	739.45	28.60	768.05	....
Raising 3 scows after storm October 30	205.04	....	....	20.51
Repairs to deck of timber superstructure	12.75	59.47	....	7.22
Placing 131 cords of stone for crib foundation	173.03	....	....	17.30
Fuel for engine and concrete house	93.30	....	93.30	....
Piling and sampling cement	148.50	....	148.50	....
Cement testing	288.00	....	288.00	....
New plant and tools not classified	601.60	329.15	....	93.08
Office work and surveys	476.52	107.07	583.59	....
Erection of plant	530.18	56.90	587.08	....
Miscellaneous items	....	95.35	95.35	....
Total	7,013.15	1,339.90	5,007.83	334.52

TABLE No. 3.—*Quantities and values of materials on hand November 30, 1896.*

Designation.	Quantity.	Cost per unit.	Value.
Portland cement ....barrels..	1,715.72	$2.75	$1,968.23
Natural cement ....do....	1,152	1.15	1,324.80
Broken stone ....cubic yards..	820	1.65	1,353.00
Sand ....do....	126	.45	56.70
Stone screenings ....do....	372.8	1.10	410.08
Burlap ....yards..	4,000	.04¾	190.00
Assorted iron	....	....	52.15
Small tools and appliances	....	....	186.50
Rubber boots ....pairs..	28	....	84.00
Total value of material on hand........	....	....	5,625.46

TABLE No. 4.—*Summary of services and materials expended on work from December 1, 1895, to November 30, 1896.*

Value of materials carried over from 1895 and used in 1896	$1,903.65
Value of materials purchased in 1896 and miscellaneous expenses	11,693.40
Value of labor and superintendence, 1896	9,405.95
Total cost	23,003.00
Less value of materials on hand and serviceable	5,625.46
Total cost of labor, superintendence, materials, and miscellaneous expenses	17,377.54

TABLE No. 5.—*Summary of all charges to concrete from December 1, 1895, to November 30, 1896, inclusive.*

Superintendence and labor making and depositing concrete	$2,392.80
Cost of materials used in the concrete	6,631.69
Cost of items auxiliary to concrete	5,007.88
Ten per cent of cost of items not directly chargeable in 1896	334.52
Ten per cent of value of plant as estimated in 1896	808.23
Total charged to concrete in 1896	15,175.12

G G 8.

CONSTRUCTING HARBOR OF REFUGE AT PRESQUE ISLE POINT, MARQUETTE BAY, MICHIGAN.

This is a new work, ordered by the act of June 3, 1896.

For the description of the locality and the interests to be benefited by the improvement, see last Annual Report, pages 2385, 2386. The act of June 3, 1896, appropriated $20,000.

The approved project is the construction of a breakwater 1,000 feet in length on the reef running out from Presque Isle Point in a general southeast direction. This will protect the ore and commercial docks of the Lake Superior and Ishpeming Railway Company and the docks of the Dead River Lumber Company.

The current appropriation is being expended in building 500 linear feet of the breakwater, under a contract with A. & D. Sang, of Duluth, Minn., dated January 20, 1897, approved February 6, 1897, and to be completed October 1, 1897, at a cost of $30.40 per linear foot.

It is proposed to give the breakwater in cross section a slope from + 0.5 feet (low-water datum) on the lake side to + 10 feet on the harbor side, thus allowing the waves to slide over the work and fall down vertically inside, with a minimum of impact and resistance.

The work will be of timber filled with stone. Under the contract, two cribs have been placed, two other cribs have been partly framed, and the superstructure has been started. The work is under the immediate charge of Mr. Clarence Coleman, United States assistant engineer, in charge, also of the breakwater in Marquette Harbor proper.

Money statement.

July 1, 1896, balance unexpended		$20,000.00
June 30, 1897, amount expended during fiscal year		855.95
July 1, 1897, balance unexpended		19,144.05
July 1, 1897, outstanding liabilities	$183.00	
July 1, 1897, amount covered by uncompleted contracts	15,200.00	
		15,383.00
July 1, 1897, balance available		3,761.05
Amount (estimated) required for completion of existing project		30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		30,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals received at Duluth, Minn., for the breakwater construction at Presque Isle Point, Marquette Bay, Michigan, opened January 11, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For the whole work complete, 500 feet in length.	For each linear foot less than 500 feet computed at the outer end, and not to exceed 100 feet in all, will allow the United States—
1	Judiah F. Hanscom and James E. Smith, Marquette, Mich	$17,962.78	$36.86
2	A. & D. Sang, Duluth, Minn	15,200.00	30.40
3	Green & Anderson, Green Bay, Wis	19,940.60	40.00
4	Powell & Mitchell, Marquette, Mich	15,495.00	25.00
5	John H. Gillett, Marquette, Mich	19,000.00	40.00
6	Louis E. Chaussee, Negaunee, Mich	19,705.00	42.00
7	Wm. McCurdy, Houghton, Mich.; Alex. McCurdy, Duluth, Minn	18,625.00	39.64
8	Mathews & Keith, Manitowoc, Wis	19,696.00	35.00
9	Porter Bros., Duluth, Minn	20,600.00	41.00
10	Saml. Meniece, Duluth, Minn	19,500.00	50.00
11	Geo. R. King and Hugh Steele, Duluth, Minn	17,900.00	40.00
12	Eugene Larocheall, Marquette, Mich	17,700.00	40.00

Abstract of existing contract.

Contract with A. & D. Sang, of Duluth, Minn., for building 500 feet of breakwater, dated January 20, 1897, approved February 6, 1897. Work commenced May 1, 1897, and to be completed October 1, 1897.

COMMERCIAL STATISTICS.

Presque Isle Point, Marquette Bay, Michigan, 1896.

Shipments.	Tons.	Receipts.	Tons.
Iron ore	290,813	Coal	8,523
Lumber	48,445		
Total	339,258		

Total exports	339,258
Total imports	8,523
Total exports and imports	247,781
Number of arrivals	207
Number of departures	207
Total number arrivals and departures	414

G G 9.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN

The harbor of Grand Marais, Mich., was only accessible for vessels drawing less than 9 feet. Once within the bay there is ample depth to float the largest vessels. As a harbor of refuge it is of pressing importance to the shipping navigating the lakes in this vicinity, as the many wrecks in this neighborhood bear witness.

The project for the improvement of this harbor was adopted in 1881, and has for its object the creation of a safe entrance into the bay for vessels of the largest size. The entrance is 500 feet in width, protected by crib piers on either side. The west pier is now 1,406 feet long, including 100 feet of pile dike, and the east pier 1,153 feet long, including 100 feet of pile dike.

A careful and comprehensive survey made in the fall of 1894 showed, when compared with previous surveys, that the harbor was slowly but surely filling up by the sand rolled in by the waves through the interval of 5,700 feet between the east pier and the eastern shore.

This fact necessitated an amendment of the project by providing for a close pile dike across this open interval. This was approved by the Chief of Engineers December 21, 1894.

A channel 150 feet wide and 17 feet deep was dredged out between the piers in 1889.

An examination made in June, 1890, showed considerable shoaling, and in 1891 it was again dredged, this time to a width of 175 feet and a least depth of over 17 feet. A partial survey made in June, 1893, showed a shoaling to 14 feet, principally opposite the portion of the west pier which extends beyond the east pier, so that with any swell on it would not be safe to bring in a vessel of more than 12 feet draft.

An examination made in June, 1894, showed that there was a least depth of 15.5 feet along the channel, and this, as before, opposite the west pier, where it extends beyond the east pier.

The amount expended on the above project as amended in 1894, up to the close of the fiscal year ending June 30, 1896, was $271,661.92.

At that time there was a navigable channel of 15 feet into and between the piers. This channel has remained practically unchanged as to depth, but not so direct, as it has been pushed over to the east just outside the entrance by a bar which appears to be working in from the west, and has advanced to a point opposite the middle line between the piers. The material for this bar comes from the sand bluffs to the west. For several years the wash from these bluffs was expended in building up the shore out along the west pier, but this action appears to have ceased, and the material seems now to be expended in building up and shoaling at the outer end of the west pier.

At the date of the last Annual Report the construction of the pile dike was going on under the contract with Mr. Francis L. McDonald. On September 1, 1896, Mr. McDonald stopped work and threw up his contract, forfeiting all retained percentages and other moneys due. Three contractors having failed to complete the work, I took possession of Mr. McDonald's plant and the material on hand, and proceeded with the work by day's labor. About 4,700 linear feet of dike was completed by the close of the season under very adverse circumstances, and was attended with some losses due to unusually early storms.

During the winter the heavy ice did some damage to the weaker detached portions. When work was resumed in the spring, 4,636 linear feet was in good condition, leaving 1,064 feet to be completed, of which 746 feet had been finished by the end of the fiscal year. It is expected that the remaining 318 feet will be completed in July, and at a total cost less than originally estimated, notwithstanding the bad luck with contractors and losses from storms to incompleted and unprotected work.

To complete the pier work according to the approved project 400 feet remains to be added to the west and 600 feet to the east pier. It is proposed to expend the remainder of the funds not used for the dike and repairs in extending the west pier about 250 feet, the work to be done by contract.

To this end a contract, after due advertisement, has been made with A. & D. Sang, of Duluth, Minn., dated March 31, 1897, approved May 5, 1897, for pier extension, at $49.98 per linear foot, work to be completed by November 1, 1897. This contract is now in force.

The renewed growth and prosperity of the town of Grand Marais reported in my last annual report have been maintained during the past year.

The work for the past three seasons has been carried on under the efficient management of Mr. E. S. Long, assistant engineer. He has labored faithfully and successfully to accomplish good results under very trying circumstances.

The commerce of this place has increased from 1,910 tons in 1887 to 90,497 tons in 1896. While the expenditure for this harbor is incidentally an aid to the local commerce, the great object is the affording a harbor of refuge for the general lake commerce. In 1892 155 vessels entered and departed; in 1896 656 vessels entered and departed.

Original estimate (see Report of Chief of Engineers, 1881, p. 2053)	$450,000
Appropriated	305,250

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich.; nearest light-house, Grand Marais, Mich.

Money statement.

July 1, 1896, balance unexpended		$33,588.08
June 30, 1897, amount expended during fiscal year		14,088.91
July 1, 1897, balance unexpended		19,499.17
July 1, 1897, outstanding liabilities	$2,232.30	
July 1, 1897, amount covered by uncompleted contracts	13,135.00	
		15,367.30
July 1, 1897, balance available		4,131.87
Amount (estimated) required for completion of existing project		*178,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of appropriations for improving harbor of refuge at Grand Marais, Mich.

By act of Congress—		By act of Congress—	
Approved June 14, 1880	$10,000	Approved September 19, 1890	$50,000
Approved March 3, 1881	20,000	Approved July 13, 1892	30,000
Passed August 2, 1882	40,000	Passed August 7, 1894	20,000
Approved July 5, 1884	35,000	Passed June 3, 1896	24,000
Approved August 5, 1886	26,250		
Of August 11, 1888	50,000	Total	305,250

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*Does not include work on pile dike.

Abstract of proposals received at Duluth, Minn., for pier extension at Grand Marais, Mich., opened March 15, 1897, by Maj. Clinton B. Sears, Corps of Engineers.

No.	Name and address of bidder.	For pier extension to include the mattress and stone foundation, etc., as per specifications (250 to 300 linear feet), per linear foot.	For stone for extra riprap in place (80 cords), per cord.
1	Eslow & Munroe, Charlevoix, Mich	$59.67	$12.50
2	Joseph A. Beauvais, Charlevoix, Mich	78.50	16.00
3	Heldmaier & Neu, Chicago, Ill	54.77	7.80
4	Green & Anderson, Greenbay, Wis	67.80	12.00
5	Alex. McCurdy, Duluth, Minn Wm. McCurdy, Houghton, Mich	53.50	6.50
6	A. J. Dupuis and William M. Blay, Detroit, Mich	63.90	20.25
7	Lipsett & Gregg, Sault Ste. Marie, Mich	85.50	13.75
8	Powell & Mitchell, Marquette, Mich	55.75	12.67
9	George Cooper, Manitowoc, Wis	57.00	9.00
10	A. & D. Sang, Duluth, Minn	49.98	8.00

Abstract of existing contract.

Contract with A. & D. Sang, of Duluth, Minn., for 250 feet pier extension, dated March 31, 1897, approved May 5, 1897; work commenced May 1, 1897, to be completed November 1, 1897.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Mich.

Vessels.	Arrivals.	Clearances.
1892—Steam	155	155
1893—Steam, 187 (tonnage, 26,645); sail, 11 (tonnage, 10,000)	198	197
1894—Steam, 160; barges, 30 (tonnage, 69,300); sail, 3	193	193
1895—Steam, 219 (tonnage, 78,000); sail and tow, 44 (tonnage, 26,800)	263	261
1896—Steam, 224 (tonnage, 210,000); sail and tow, 104 (tonnage, 100,000)	328	328

Principal articles of export and import.

Exports.	Tons.	Imports.	Tons.
Lumber	78,000	Merchandise	2,600
Shingles	2,125	Coal	4,000
Lath	2,122	Hay	500
Fish	150	Oats	1,000
Total	a 82,397	Total	8,100
Valuation (including logs)	$300,000	Valuation	$391,650

a Does not include some 24,000,000 feet of logs.

Receipts and shipments for ten years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,910	1891	1,356	1895	58,208
1888	6,270	1892	5,020	1896	90,497
1889	8,686	1893	35,450		
1890	9,405	1894	39,250		

Approximate value of commerce for 1896, $691,650.

G G 10.

PRELIMINARY EXAMINATION OF HARBOR AT PORTWING, WISCONSIN.

[Printed in House Doc. No. 118, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 5, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated November 27, 1896, by Maj. Clinton B. Sears, Corps of Engineers, of the results of a preliminary examination of harbor at Portwing, Wis., provided for by the river and harbor act of June 3, 1896.

It is the opinion of Major Sears, concurred in by Col. Henry M. Robert, Corps of Engineers, division engineer, that this harbor is worthy of improvement by the General Government.

I concur in the views of these officers in so far as to advise the making of a survey of the harbor, estimated to cost $500, upon the results of which a more reliable opinion as to the extent of the improvement justified by the commerce involved can be formed.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., November 27, 1896.

GENERAL: In compliance with your letter of June 16, 1896, I have the honor to submit the following report on the preliminary examination of the harbor of Portwing, Wis., provided for in section 8 of the river and harbor act of June 3, 1896.

Portwing is situated on Flag Lake about three-quarters of a mile within the entrance to Flag River, which latter lies on the south shore of Lake Superior, nearly due east from Duluth and distant therefrom about 34 miles.

This harbor was reported on by me under date of October 20, 1894, under the name of "Flag Lake and the mouth of Flag River, Wisconsin," in compliance with the river and harbor act of August 17, 1894. This report was published in House Ex. Doc. No. 65, Fifty-third Congress, third session, and as part of Appendix H H 12, pages 2580–2583, Report of Chief of Engineers, 1895.

As Portwing and its vicinity were familiar to me by reason of my former examination, I have confined the present examination to a single visit, by tug, to see what progress the village had made during the last two years and to what extent its people had carried out their plans formulated in 1894.

To place the whole matter in compact shape and to avoid the inconvenience of referring back to the previous report, I herewith quote verbatim what was then said:

> Flag River is a stream about 13 miles in length, has a limited watershed, and drains a rough, broken country, fairly well wooded. The lower reach of the river has a gentle slope, and near the mouth is a slough opening into Flag Lake. This latter is

a body of water measuring along its axis about 1¼ miles and having an average width of 300 feet. The portion next the entrance has a width of 800 feet and a length of 1,400 feet.

The maximum available depth of water is about 7 feet at low water. The banks, except on the south side, are low and swampy, and this feature extends nearly to Lake Superior, from which the wet ground is separated by a low sand spit thrown up by the lake. On the south side of Flag Lake the banks are high and slope up into a general plateau, on which a town site, known as Portwing, has been platted. The mouth of the river, which originally entered Lake Superior at an acute angle, has been diverted by artificial means and now flows into the lake at right angles. Two rough, round timber-crib piers, about 250 feet apart, have been built by the promoters of the town site, and they propose to dredge out between them and up into Flag Lake, the entrance to which is about 2,100 feet from the outer ends of the piers. The bottom of the river and lake is of soft material, easily dredged. The 18-foot lake contour runs in close to the outer ends of the piers, between which is a depth of 12 feet. Farther in, however, there is only 1½ feet at low-water stage.

The piers are well located and the whole locality is susceptible of radical improvement at a comparatively low cost. If in the future there should appear to be any real demand for a harbor of refuge along the south shore between Superior and the Apostle Islands, a stretch of only 58 miles, this locality is the best adapted for the purpose of any point near the middle of this reach of coast, for the reason that deep water approaches close to the shore and ample harbor room can be secured in Flag Lake. At present, however, I think there is no pressing necessity for a harbor of refuge along this portion of the south shore.

The town of Portwing has about 17 buildings of all kinds, and perhaps 100 people live in the immediate vicinity. The railroad is distant about 14 miles. There are no commercial industries yet established, except, perhaps, a small sawmill and a brickyard on the beach some 2,000 feet from the entrance.

The promoters of the town site claim that parties are negotiating for ground on which to build a sawmill; that said parties will put up a plant costing $25,000, and that said plant when finished will cut 100,000 feet B. M. of lumber per day. The whole matter is yet in the air, and a plant to cut 100,000 feet a day will cost $50,000 or $60,000. They also claim that there are 400,000,000 feet of millable timber on the Flag River watershed. Their rivals at Iron River say there are not 50,000,000. There may be more than the latter amount, but certainly not as much as the former.

At the upper end of Flag Lake a small stream empties into the lake, and half a mile up this stream is a quarry site where high ledges of apparently good sandstone crop out. The development of this quarry site is one of the industries claimed as about to be undertaken. From the number of good quarries already opened along the south shore the wisdom of opening another for some years yet is doubtful.

For the reason, therefore, that there are no active commercial industries actually established at this locality, and that there is no reasonable assurance that any of much magnitude will be started for a number of years, I am of the opinion that this locality is not at present worthy of improvement by the General Government.

I found on my recent visit that the town had improved very materially, it having now over 50 substantial buildings and probably 200 inhabitants in the town itself, and a possible immediately surrounding population of some 300 or 400 more.

The citizens of the place have expended some $19,000 in building piers and dredging out between them and for 1,000 feet or so inside. This channel, though narrow, is in a good navigable condition and permits vessels drawing 13 feet to get in and lie up alongside the lumber dock. A substantial sawmill is in active operation. It can cut 75,000 or 80,000 feet B. M. of lumber in a day of twenty-four hours, and its capacity can be easily and cheaply increased by putting in an additional saw. This mill is reported to have cut during the past summer 8,500,000 feet B. M., and it is claimed that some 9,000,000 feet B. M. of lumber have been shipped since the establishment of this port.

Within the past year quite a local commerce has grown up along the south shore between Duluth and Ashland, which is carried on in tugs, scows and small steam propellers. These vessels, from their size, can not hold out against a heavy sea long enough to reach Duluth or the shelter of the Apostle Islands, or to take refuge in Two Harbors, on the north shore. A safe and accessible harbor for this class of vessels, therefore, would seem now to be desirable, and this harbor is the best adapted for this purpose of any on the south shore between Duluth and the Apostle Islands.

In view, therefore, of the growing importance of Portwing, with its lumber industry already developed and other industries in fair way for development, of the energy and enterprise of its people as evinced by their taxing themselves heavily to improve their harbor instead of waiting with folded hands for the Government to help them, and of the wisdom of encouraging the local commerce along the south shore by providing a harbor of refuge for small coasting vessels, I am of the opinion that the harbor at Portwing is worthy of improvement by the General Government.

The cost of a survey whereon to base a project and estimate will be $500, and the survey will take five or six weeks.

I inclose herewith copies of letters received from T. N. Okerstrom and W. C. Allan, two prominent citizens of Portwing, who have expended much time and money in developing the harbor.

I remain, General, very respectfully,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, December 2, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with Major Sears in the opinion that the harbor of Portwing, Wis., is worthy of improvement by the General Government.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

LETTER OF MR. W. C. ALLAN.

PORTWING, WIS., *September 25, 1896.*

DEAR SIR: Your favor of recent date, making inquiries relative to the present condition of Flag River and Flag Lake, is at hand, and in reply we beg to say that the claims of the town-site promoters as mentioned in your previous report have been verified, as the following will show:

The village of Portwing now numbers about 55 buildings, with a population, including the near vicinity, of 600. Among the buildings there are 5 stores, 3 hotels, 1 church, and 1 schoolhouse, and in addition there is another church in course of erection. The mill also is a developed fact, and has been in operation since June, 1895. It cost $30,000, and can cut from 90,000 to 100,000 per day. The quarry spoken of in your report has not been developed, but another one on the point just west of the entry has been and is in active operation. The piers are about as when you were here, with the exception that the east one has been partly covered.

The sum of $13,150 has been expended in dredging, and the channel now extends from near the piers about 2,800 feet toward Flag Lake. Between the piers this channel is 70 feet wide on the bottom, with a depth of 16 feet, and from the outer end of the lumber docks the channel is 70 feet at the top and 40 feet at the bottom, with an average depth of 14 feet. When dredging stopped there was only 14 feet of water between the piers, but the extra 2 feet is the result of the tide and current.

In verifying the statement of the amount of timber available and tributary to this place, we have the following, based upon the buying estimate:

Rutledge & Weyhauser	150,000,000
Finley Morrison	45,000,000
Moore & Co	35,000,000
Frank Boutin	10,000,000
Stein & Levy	25,000,000
Homesteaders yet unsold	72,000,000
Parties unknown	75,000,000

We wish to again refer to the matter of our harbor enough to say that several fleets have loaded here this summer, and all unite in high praise of the place. Owing to the exposed position of the stone quarry above referred to it is impossible to load during a storm or wind, and when caught there in a blow boats are forced to seek shelter in the harbor.

The small mill and brickyard are mentioned in your report.

Very respectfully,

W. C. Allan.

Maj. Clinton B. Sears,
Corps of Engineers.

LETTER OF MR. T. N. OKERSTROM.

The Ebony Manufacturing Company,
Lumber and General Merchandise,
Portwing, Wis., November 21, 1896.

Dear Sir: Before you make a new report on our harbor at Portwing, Wis., I wish to call your attention to what has been done in the past two years, which we consider worthy of consideration, as the improvements were made during the prevailing hard times.

When you were here two years ago we had only a few buildings, and I made statements in regard to what we intended to do and what we expected in the near future. The sawmill which I mentioned is an assured fact, and has been in operation for nearly two years, and is a larger plant than was expected. Since 1893 we have expended nearly $19,000 in the improvement of our harbor. We have a channel dredged about 3,000 feet in length and from 60 to 100 feet in width, and from 14 to 15 feet deep at low-water stage, and at the outer end of the channel the current has washed until it is now from 16 to 17 feet deep.

This port has already been of help to boats and tugs that have been out in stormy weather, and came in here for shelter, and during any severe storm there has been from one to six boats lying inside. Have also had several boats loaded with oak and pine which have taken out about 9,000,000 feet. I stated two years ago that we had about 400,000,000 of pine tributary to this point, which statement, I notice by your report at that time, was disputed by others. I have never been in the habit of making false statements, and I therefore wish to append the names and amounts as follows:

Weyhauser & Co	150,000,000
Represented by Finley Morrison	45,000,000
H. C. Putnam	30,000,000
F. Boutin	10,000,000
J. B. Moore & Co	30,000,000
Homesteaders	75,000,000
Cranberry Lumber Co	4,000,000
Stein & Levy	10,000,000
Parties unknown to me	55,000,000

There is in addition about 15,000,000 oak. We have also a great deal of birch, poplar, elm and spruce, while the bottom lands are covered with cedar which is used for ties, paving, poles, and shingles.

There is only one stone quarry in operation, but we have the finest quality of brownstone that has been found along the south shore of Lake Superior, and, without question, will amount to a great deal in the near future.

Our village has had no "boom," but still we have 55 good buildings, 1 schoolhouse, and 2 churches. We have in the village and its near vicinity between 500 and 600 people. The authorized census shows 84 children older than the school age of 4 years.

Ground is now being cleared and prepared for another mill, which will include a planing and shingle mill, which is being built by Allan & Co., of Pennsylvania.

The Portwing Brick Manufacturing Company have purchased new machinery with a view to further increasing their capacity.

The piers we built for the entrance of the harbor are not completed, as we were unable to get stone enough in time, and they should be extended out farther, and something should soon be done to protect the work already in. From the upper end of the channel we have now only about 200 feet to enter into Flag Lake, which is a body of water large enough to room many of the largest lake boats.

The water in Flag Lake is from 7 to 15 feet deep, being about 9 feet deep immediately in front of the village. The bottom of Flag Lake is about 3 to 7 feet of loose muck and underneath that is clay.

Judging from the present undercurrent it would stand to reason that should Flag Lake be opened the additional force of water would have a tendency to clear the channel and cut it deeper, especially after the piers are placed in proper condition.

Now, I have endeavored to show you the reasons why I, together with our people, ask and urge you and Congress for aid toward our improvements. Many of our farmers and homesteaders have mortgaged their homes to help this harbor, and have taken their last dollar in struggling to pay the dredging.

We therefore repectfully ask you to so recommend that we may have aid in finishing our work and protecting what we have already done.

Yours, truly,

T. N. OKERSTROM.

CLINTON B. SEARS,
Corps of Engineers.

G G 11.

MODIFICATION OF HARBOR LINES IN SUPERIOR AND ALLOUEZ BAYS AT DULUTH AND SUPERIOR HARBOR, MINNESOTA AND WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 21, 1897.

GENERAL: I herewith transmit a tracing* setting forth certain proposed changes in the harbor lines at the eastern end of Superior Bay, where it joins Allouez Bay.

The harbor lines of Allouez Bay were approved by the Secretary of War March 30, 1893, "subject to slight changes that may be found to be necessary after an official survey has been made."

The changes shown upon the tracing herewith are those referred to, and are necessary to complete the harbor line arrangement and to comply with the approved project for the improvement of the harbor.

It is recommended, therefore, that the said changes be officially approved.

Very respectfully,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

(Through the Division Engineer).

[First indorsement.]

ENGINEER OFFICE U. S. ARMY,
NORTHWEST DIVISION,
Green Bay, Wis., July 26, 1897.

Respectfully forwarded to the Chief of Engineers, U. S. A. Recommended for approval.

J. W. BARLOW,
Colonel, Corps of Engineers, Division Engineer.

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* Not printed.

[Sixth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 18, 1897.

Respectfully submitted to the Secretary of War.

On March 30, 1893, harbor lines for Allouez Bay, Wisconsin, were established by the Secretary of War "subject to slight changes that may be shown to be necessary after an official survey has been made."

A survey of Allouez Bay has been made and Major Sears now submits a chart showing certain proposed modifications in the harbor lines, which he states are the changes referred to above and are necessary to complete the harbor line arrangement and comply with the approved project for the improvement of the harbor.

Certain modifications in the harbor line at the eastern end of Superior Bay are also proposed.

It is recommended that the proposed changes, as shown on the accompanying chart, be approved, and that the Secretary place his approval both upon this paper and upon the tracing herewith, which has been prepared for his signature.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

[Seventh indorsement.]

WAR DEPARTMENT,
August 23, 1897.

Approved as recommended by the Chief of Engineers.

G. D. MEIKLEJOHN,
Acting Secretary of War.

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